Reference Room

RESEARCH PROGRAM ON CONVERSION OF SALINE WATER TO FRESH WATER

HEARINGS

BEFORE THE

SUBCOMMITTEE ON IRRIGATION AND RECLAMATION

OF THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS HOUSE OF REPRESENTATIVES

EIGHTY-FOURTH CONGRESS

FIRST SESSION

ON

H. R. 2104 and H. R. 2126

TO AMEND THE ACT OF JULY 3, 1952, RELATING TO RESEARCH IN THE DEVELOPMENT AND UTILIZATION OF SALINE WATERS

FEBRUARY 16 AND 17, 1955

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RESEARCH IN THE DEVELOPMENT AND UTILIZATION OF SALINE WATERS

WEDNESDAY, FEBRUARY 16, 1955

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON IRRIGATION AND
RECLAMATION OF THE COMMITTEE ON
INTERIOR AND INSULAR AFFAIRS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10:55 a. m., in the committee room, New House Office Building, Hon. Wayne N. Aspinall (chairman) presiding.

Mr. ASPINALL. The Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs will now be in session to consider H. R. 2126, by our chairman, Congressman Engle, of California, and H. R. 2104, by our colleague, Congressman Bow, of Ohio, former member of this committee, one who is very interested in the subject matter of the legislation.

These two bills, which are identical, would amend existing law to provide for uninterrupted continuation of the saline water conversion research program. This program has the objective of developing economically feasible processes for converting saline water to fresh water. The research program is accomplished under the direction of the Secretary of the Interior through (1) scientific research conducted by federally financed grants and contracts, (2) encouraging such development by correlating and coordinating efforts in this field, and (3) stimulating the interest of private and public organizations and individuals in the problem.

If there is no objection, I shall make the memorandum prepared by the committe staff a part of the record at this point following the bill itself. Is there any objection?

There is no objection. It is so ordered.

(H. R. 2104, H. R. 2126, and the committee staff memorandum follow:)

[H. R. 2126, 84th Cong., 1st sess.]

A BILL To amend the Act of July 3, 1952, relating to research in the development and utilization of saline waters

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act of July 3, 1952 (66 Stat. 328; 42 U. S. C., secs. 1951 ff.), is hereby amended as follows:

(1) By modifying subsection (a) of section 2 of said Act so as to read: "by means of research grants and contracts as set forth in subsection (d) of this section and by use of the facilities of existing Federal scientific laboratories within the monetary limits set forth in section 8 of this Act, to conduct research and technical development work, to make careful engineering studies to ascertain the lowest investment and operating costs, and to determine the best plant designs and conditions of operation."

(2) By modifying section 8 of said Act so as to read: "There are authorized to be appropriated such sums, but not more than $6,000,000 in all, as may be required (a) to carry out the provisions of this Act during the fiscal year 1953 to 1963, inclusive, (b) to finance for not more than two years beyond the end of said period such grants, contracts, cooperative agreements, and studies as may theretofore have been undertaken pursuant to this Act, and (c) during the same additional period plus one more year, to correlate, coordinate, and round out the results of studies and research undertaken pursuant to this Act. Departmental expenses for direction of the program authorized by this Act and for the correlation and coordination of information as provided in subsection (d) of its section 2 shall not exceed $1,500,000, and not more than $500,000 shall be expended for research and development in Federal laboratories. Both of said sums shall be scheduled for expenditure in equal annual amounts insofar as is practicable."

[H. R. 2104, 84th Cong., 1st sess.]

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(2) By modifying section 8 of said Act so as to read: "There are authorized to be appropriated such sums, but not more than $6,000,000 in all, as may be required (a) to carry out the provisions of this Act during the fiscal years 1953 to 1963, inclusive, (b) to finance for not more than two years beyond the end of said period such grants, contracts, cooperative agreements, and studies as may theretofore have undertaken pursuant to this Act, and (c) during the same additional period plus one more year, to correlate, coordinate, and round out the results of studies and research undertaken pursuant to this Act. Departmental expenses for direction of the program authorized by this Act and for the correlation and coordination of information as provided in subsection (d) of its section 2 shall not exceed $1,500,000, and not more than $500,000 shall be expended for research and development in Federal laboratories. Both of said sums shall be scheduled for expenditure in equal annual amounts insofar as is practicable."

FEBRUARY 14, 1955.

MEMORANDUM BY COMMITTEE STAFF

Subject: H. R. 2126 and H. R. 2104.

PURPOSE

These two bills, which are identical, would amend existing law to provide for uninterrupted continuation of the saline water conversion research program. This program has the objective of developing economically feasible processes for converting saline water to fresh water. The research program is accomplished under the direction of the Secretary of the Interior through (1) scientific research conducted by federally financed grants and contracts, (2) encouraging such development by correlating and coordinating efforts in this field, and (3) stimulating the interest of private and public organizations and individuals in the problem.

EXISTING LAW

Legislation was enacted in 1952 which initiated the saline water conversion research program. The legislation is identified as Public Law 448 of the 82d Congress, the act of July 3, 1952. A copy of this act is attached.

NEED FOR AMENDING THE EXISTING LAW

Public Law 448 limits the saline water research program to 5 years and the expenditure to $2 million. Although the program still has 2 years to run, the Solicitor of the Department has ruled that under the present act all studies and research work must be completed during this 2-year period, including the correlation and coordination of the results and reports thereon. If there is no assurance that the program will be continued, many of the studies and much of the research work now in process will have to be stopped in the near future without being completed in order to comply with the Solicitor's ruling. Not only that, but the scientists who are conducting this research will be reluctant to follow up new ideas if the whole program is expected to be suddenly ended. In addition to the need for assuring uninterrupted continuation of the program there has developed a need for using existing Federal scientific facilities to accomplish a limited amount of technical assistance. This cannot be done under existing law. Department witnesses will present a more detailed justification for extending the program.

ANALYSIS OF THE LEGISLATION

H. R. 2126 and H. R. 2104 would provide for uninterrupted continuation of the saline water conversion research program and permit the officials in charge of the program to have the advantage of a limited amount of technical assistance from existing Federal scientific facilities. Section 2 (a) of the act of July 3, 1952 would be amended to permit use of the facilities of existing Federal scientific laboratories. Section 8 of said act would be amended to raise the limit of the funds authorized to be appropriated from $2 million to $6 million. The $6 million includes the amounts already expended under the program during the last 3 years. Of the $6 million, not more than $1,500,000 could be expended for the direction of the program and for the correlation and coordination of the studies and information, and not more than $500,000 could be expended for research and development in Federal laboratories. Section 8 would also be amended to extend the program through fiscal year 1963 and provide for an additional year for correlating and coordinating the results of studies and research undertaken under the program.

Act of July 3, 1952—Saline Waters

An act to provide for research into and development of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes (ch. 568, 66 Stat. 328)

POLICY OF THE CONGRESS

Section 1. That, in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground waters throughout the Nation, it is the policy of the Congress to provide for the development of practicable low-cost means of producing from sea water, or from other saline waters, water of a quality suitable for agriculture, industrial, municipal, and other beneficial consumptive uses on a scale sufficient to determine the feasibility of the development of such production and distribution on a large-scale basis, for the purpose of conserving and increasing the water resources of the Nation.

AUTHORITY OF SECRETARY

Sec. 2. In order to carry out the purposes of this Act, the Secretary of the Interior, acting through such agencies of the Department of the Interior as he may deem appropriate, is authorized—

(a) by means of research grants and contracts as set forth in subsection (d) of this section to conduct research and technical development work, to make careful engineering studies to ascertain the lowest investment and operating costs, and to determine the best plant designs and conditions of operation;

(b) to study methods for the recovery and marketing of by-products resulting from and incident to the production of water as herein provided for the purpose of ascertaining the possibilities of offsetting the costs of water production in any area by the commercial utilization of such products;

(c) to acquire, by purchase, license, lease, or donation, secret processes, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided*, That the land or

other property acquired hereunder shall not exceed that necessary to carry on the experiments and demonstrations for the purposes herein provided;

(d) to engage, by noncompetitive contract or otherwise, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work, and to the extent appropriate to correlate and coordinate the research and development work of such educational institutions, scientific organizations and industrial and engineering firms; and

(e) to cooperate with any other Federal, State, or municipal department, agency, or instrumentality, and with any private person, firm, educational institution, or other organization in effectuating the purpose of this Act.

COOPERATION WITH DEFENSE DEPARTMENT

SEC. 3. Research undertaken by the Secretary of the Interior under the authority contained in this Act shall be coordinated or conducted jointly with the Department of Defense to the greatest practicable extent compatible with military and security limitations, to the end that research and developments under this Act, which are primarily of a civil nature will contribute to the defense of the Nation and that research and developments in the same field which are primarily of a military nature and are conducted by the Department of Defense will be made available to advance the purposes of this Act and to strengthen the civil economy of the Nation.

DISPOSAL OF WATER AND PRODUCTS

SEC. 4. The Secretary of the Interior is authorized, for the sole purpose of this Act, to dispose of all water and other products produced as a result of his operations under this Act purusant to regulations to be prescribed by him: *Provided*, That nothing in this Act shall be construed to alter existing law with respect to the ownership and control of water.

DISPOSITION OF MONEYS RECEIVED

SEC. 5. All moneys received for products of the plants under this Act shall be paid into the Treasury as miscellaneous receipts.

REPORTS TO PRESIDENT AND CONGRESS

SEC. 6. The Secretary of the Interior shall make reports to the President and the Congress at the beginning of each regular session of the action taken or instituted by him under the provisions of this Act. The report shall include suitable recommendations for further legislation.

RULES AND REGULATIONS

SEC. 7. The Secretary of the Interior may issue rules and regulations to effectuate the purposes of this Act.

$2,000,000 AUTHORIZED TO BE APPROPRIATED—LIMITATIONS

SEC. 8. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $2 million, for a five-year period, to carry out the provisions of this Act: *Provided*, That departmental expenses for the correlation and coordination of information over such five-year period shall not exceed the sum of $500,000: *Provided further*, That such departmental expenses shall be scheduled in equal amounts for each year of such period insofar as practicable.

Legislative history: H. R. 6578, Public Law 448 in the 82d Congress. House Report 1519.

Mr. ASPINALL. Is Congressman Wilson of California in the room?

Apparently he is not.

Is Congressman Matthews in the room?

Apparently he is not.

Is Congressman Bow in the room?

Apparently he is not.

I would ask unanimous consent to have included at this place in the record statements prepared by Congressman Bow, of Ohio, and Congressman Matthews, of Florida.

Is there any objection?

Hearing none, it is so ordered.

(The statements referred to follow:)

STATEMENT OF HON. FRANK T. BOW

Mr. CHAIRMAN. I am delighted to address this committee on behalf of legislation to continue and expand the saline water conversion program. I have been very much interested in this program since its inception during my service on this committee, having taken an active part in the enactment of the basic legislation at that time. As areas once blessed with an abundance of water find themselves unable to supply the constantly increasing demands of our modern society, the problem of increasing our water supplies becomes of greater importance every day. The saline water conversion program offers one possibility for alleviation of the shortages we are now experiencing and the more acute shortages that seem to be just ahead. It is for that reason I was happy to join with your chairman in introducing H. R. 2104, the companion measure to H. R. 2126, to give new scope and impetus to the research on saline water.

In view of my interest in this problem, it has been gratifying to me that a leader in the industrial development has been the Griscom-Russell Co., of Massillon, Ohio, in my congressional district. Griscom-Russell is cooperating with the Government in the manufacture of distillation equipment and in other aspects of the program.

Griscom-Russell, or any other industrial firm, cannot venture all of the capital that is required for research and development of sea-water conversion. It has been clear to me that the Federal Government should support part of this work and should coordinate to some extent the independent research that has been in progress.

Three years ago, with the study in its infancy, we authorized a small-scale investigation to prove out new ideas. I am impressed with the progress and the program that is underway, but it is clear that much remains to be done on research needed to develop equipment to supply fresh water in large quantities at costs which can be afforded in the continental United States.

The successful results that are now being obtained under the program, as discussed quite thoroughly in the Third Annual Report of the Secretary of the Interior on Saline Water Conversion, make it essential at this time to assure continuity in this vital activity. It was expected that the law which we originally enacted would need to be extended if the results justify. I feel the time has come to give the assurance that is needed both by the Department and the private scientists and engineers that their work will be carried through to fruitful ends.

It is time now to develop small pilot plants in sizes ranging from that of this desk to perhaps as large as this room, for the few more promising processes, so that the plant cost and operation costs can be worked out as provided in the present law. Such developmental work will cost more money than laboratory research and here again it is not possible for private industry to take over at the pilot-plant stage. The supplying of water has always been looked upon as a public or semipublic activity. For this reason I feel that the small increase in Federal support at this time is more than justified.

Likewise the provision for a small amount of research in existing Government laboratories is necessary both to assure the development of new ideas in which no private laboratory is interested in working and for checking and confirming reported results.

I should like to add, Mr. Chairman, that I was pleased to learn that the activity was established in the Office of the Secretary of the Interior rather than in one of the bureaus of the Interior Department. This is a nationwide problem. The research work is being carried on by scientific organizations in New England, New York, Florida, Ohio, Minnesota, Texas, Washington and California, and the problem areas of water shortages are found in all sections.

It is appropriate, therefore, that the work be conducted by the Secretary, rather than a subordinate sectional agency, as had been suggested.

Mr. CHAIRMAN. This is a vital and potentially fruitful program, of the greatest importance to our people. I trust that the committee will approve H. R. 2104 and 2126.

58839—55——2

STATEMENT OF CONGRESSMAN D. R. (BILLY) MATTHEWS

Please let me express my appreciation to this committee for giving me the opportunity to express myself on behalf of H. R. 2126.

In my opinion our saline water conversion program is of tremendous importance and I favor any reasonable and constructive attempt which is being made in this field. As we all know, one of our great problems in America today is that of the vanishing water supplies of many of our cities and towns. We have been warned repeatedly by experts who have studied our water supply that we should take steps now to prevent tragic shortages of our indispensable water in the future. Naturally our vast oceans with their inexhaustible supply of salt water could be a source of meeting all our needs if we could find some practical method of converting this saline water for ordinary use. I sincerely believe that H. R. 2126 is an earnest attempt to move us farther along toward a solution of this problem, and I am happy to associate myself with the sponsors and supporters of this measure.

As the members of this committee may know, my home State of Florida has a particular interest in this problem of saline water conversion, due to the fact that we are surrounded on three sides by salt water. The Eighth Congressional District of Florida which I represent touches on both the Atlantic Ocean and the Gulf of Mexico. Another direct way in which Florida is interested is through the University of Florida at Gainesville. The University of Florida was granted a contract for research on the saline water conversion program in 1953 by the Department of the Interior. Several of the outstanding authorities on water supplies and water chemistry are professors at the University of Florida. I would also like to mention that because of the rapidly expanding population in Florida, heavy drafts are being made on municipal water supplies in several areas. This means that quite possibly these areas will be facing critical water supply problems in the near future.

In closing, I want to urge the most thorough and sympathetic consideration of H. R. 2126 by this honorable committee and to express the hope that the Federal Government will explore all proper avenues of research in this field. Thank you very much.

D. R. (BILLY) MATTHEWS,
Member of Congress.

Mr. HOSMER. Mr. Chairman?

Mr. ASPINALL. I also would ask unanimous consent that any other member of the House of Representatives who wishes to file a statement may have the privilege of filing it following the statements which have just been ordered printed in the record. Is there any objection?

Hearing none, it is so ordered.

Now the Chair recognizes the gentleman from California.

Mr. HOSMER. I just wanted to ask unanimous consent to the same request you have just made.

Mr. ASPINALL. There is no report from the Department as yet. If the report is received within a reasonable length of time, it will be made a part of the record at the time when it is received, and we shall await its receipt before final action on this bill.

We have present, representing Assistant Secretary of the Interior, Mr. Aandahl, Mr. Edward Frye, who is assistant to Mr. Aandahl.

Mr. Frye, do you have a statement you wish to make?

Mr. FRYE. Just about 5 minutes, sir. I have no prepared statement.

Mr. ASPINALL. We will be glad to hear from you, and then before you introduce your associate, Mr. Jenkins, the Chair would like to hear from one of the witnesses who is unable to be here tomorrow. You may proceed.

STATEMENT OF EDWARD FRYE, SPECIAL ASSISTANT TO ASSISTANT SECRETARY OF THE INTERIOR AANDAHL

Mr. FRYE. Mr. Chairman, we came up here this morning prepared to say that we did not have a clearance from the Budget Bureau on this proposed legislation. However, since we have been here we have a telephone clearance.

Mr. ASPINALL. We are glad to hear that.

Mr. FRYE. And we did not have time to have the letter prepared and sent up.

There is one reservation, however, in the Budget Bureau's telephone message which came to the legislative counsel, and that is that they agreed with everything that was in the bill with the exception of the amount of money to be authorized, that of $6 million. They said they would have us a letter, and we will have it up before the committee in a short time.

Mr. Chairman, with your permission, I would like to insert in the record a copy of a solicitor's opinion of November 23, 1954.

Mr. ASPINALL. Hand it to the professional staff member.

(The document was handed to Mr. McFarland.)

Mr. FRYE. We requested this opinion in order to give us some idea of how long this legislation could go, or could we do any work after the original 5-year limitation had been expired.

The Solicitor's opinion, in brief, says contracts should not be entered into pursuant to the act of July 3, 1952, which calls for the performance by a contractor or requires work by departmental employees beyond the termination of the 5-year period that appropriations are authorized to be made for carrying out the purposes of the act. The 5-year period during which appropriations are available for carrying out the purposes of the act was initiated on July 15, 1952, by the appropriation of $125,000 by the Supplemental Appropriation Act of 1953.

This means that on July 15, 1957, all activity under the program must cease. That includes research being performed that should be performed by our contractors and those under grants and also any activities within the Department. That, together with the progress that we feel is being made in the program, is the reason that the Department is endorsing the legislation and urging its approval.

We do believe that progress is being made, but we are not so optimistic as to believe that the best solution may be found by the time of the cutoff date. For that reason we do urge the committee to give approval to the program.

Mr. ASPINALL. I would like to advise the committee that the correspondence from the Solicitor's Office is substantially in conformity with the statement made.

Is there any objection to having it made a part of the record at this point in the hearing?

Hearing none, it is so ordered.

(The document referred to follows:)

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SOLICITOR,
Washington, D. C., November 23, 1954.

MEMORANDUM

To: Director, Saline Water Conversion Program.
From: Acting Solicitor.
Subject: Limitation on funds—Saline Water Act.

Your memorandum of October 22 requests my opinion as to the legality of contracting for the performance of services pursuant to the act of July 3, 1952 (42 U. S. C. sec. 1951 et seq.), when such services would extend beyond the 5-year period prescribed in section 8 of the act.

You have advised that—

"* * * The contract research for which these funds [appropriation made pursuant to the act] are used each year is for work performed over a period usually extending beyond the end of the fiscal year in which the contract is executed. The term of such contracts averages about 1 year but in some cases may be 2 or 3 years. Thus funds appropriated during the final and fourth year of the program would ordinarily be used for research some of which would be performed subsequent to July 3, 1957."

Section 8 of the act of July 3, 1952 (42 U. S. C. sec. 1958), reads as follows:

"There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $2,000,000, for a five-year period, to carry out the provisions of this Act: *Provided*, That departmental expenses for the correlation and coordination of information over such five-year period shall not exceed the sum of $500,000: *Provided further*, That such departmental expenses shall be scheduled in equal amounts for each year of such period insofar as practicable."

Although this section speaks in terms of authorizing appropriations, its purpose clearly is to limit the amount that may be appropriated and the period of time during which such appropriations may be made and expended. The phrase "for a 5-year" period relates not only to that period of time for which sums appropriated may be expended for services under research contracts and grants, but also to that period of time for which payments may be made for work performed by departmental employees on such activities. It is my view that contracts should not be entered into pursuant to the act which would extend beyond the 5-year period. Furthermore, it appears that such contracts should call for the termination of work and the submission of reports thereunder a sufficient time in advance of the expiration of the 5-year period for the Department to perform the correlation and coordination work within such 5-year period.

Because of the view expressed above, we should also answer the question "When does the 5-year period begin?" so that its termination may be known. I believe that such period must be construed as beginning with the date that appropriations were first made pursuant to the Saline Water Act and not from July 3, 1952, the date on which that act was approved. The limitation of the 5-year period is directly related to and contained in the appropriation section of the Saline Water Act as distinguished from its functional provisions. The first appropriation for the purpose of carrying out the provisions of the Saline Water Act, in the amount of $125,000, was made by the Supplemental Appropriation Act, 1953, approved July 15, 1952 (66 Stat. 637, 642). It is my view that the approval date of that appropriation act, July 15, 1952, must be considered as the date on which the "5-year period" was initiated.

J. REUEL ARMSTRONG,
Acting Solicitor.

Mr. ASPINALL. Does that complete your statement, Mr. Frye?

Mr. FRYE. Yes, sir.

Mr. ASPINALL. Mr. Frye, do you wish to present Mr. Jenkins or do you wish the chairman to present him?

Mr. FRYE. If you had any questions you wish to ask me——

Mr. ASPINALL. You will be asked questions at the same time Mr. Jenkins is after he has presented his statement.

Mr. FRYE. Mr. Jenkins is the director of the saline water conversion program, which is in the immediate office of Assistant Secretary Aandahl.

Mr. ASPINALL. Mr. Jenkins, we are very glad to have you with us.

STATEMENT OF DAVID S. JENKINS, DIRECTOR, SALINE WATER CONVERSION PROGRAM, DEPARTMENT OF THE INTERIOR

Mr. JENKINS. Thank you, Mr. Chairman, and members of the committee.

Mr. Chairman, I had planned to proceed at somewhat greater lengths than I will be able to do so now. I have 4 or 5 matters which I thought I would like to bring to the attention of the committee, and then tomorrow we have 4 of our research contractors, who are working on some of the most promising processes, who will each present a 10- to 15-minute discussion of the processes that each is working on.

With your permission, we should like to submit for the record a rather detailed statement, copies of which have been supplied to the members of the committee.

Mr. ASPINALL. And you wish to talk extemporaneously?

Mr. JENKINS. Yes. And then I would like to summarize that.

Mr. ASPINALL. Is there any objection?

If not, the statement will be made a part of the record and you may proceed.

(The statement referred to follows:)

STATEMENT OF DAVID S. JENKINS, DIRECTOR, SALINE WATER CONVERSION PROGRAM

Mr. Chairman and members of the committee, we are appearing today and tomorrow to provide factual information on the saline water conversion program for use in consideration of the proposed amendment H. R. 2126 to the act of July 3, 1952, Public Law 448, 82d Congress, 2d session.

The need for additional fresh water in the United States and throughout the world and the need for rectification of the ever-increasing salinity of many of our inland streams and underground waters was thoroughly established by this committee and other committees of the Congress prior to enactment of Public Law 448. Therefore, unless the committee especially wishes otherwise I have not planned at this time to repeat discussions of those needs, which are even greater today than they were in 1952. Instead my remarks are directed primarily to the activities under the present program.

I. ORGANIZATION OF PROGRAM AND METHODS OF OPERATION

It was originally suggested that the activity might be handled within the Bureau of Reclamation. A small group of technical personnel within the Bureau of Reclamation was assigned to initiate the work. Because the activity was directly related to several of the bureaus in the Department, each of which was in a position to make some technical contribution, after a few months the activity was transferred from the Bureau of Reclamation to the Office of the Secretary by order of former Secretary Chapman on December 16, 1952. Then in the spring of 1953 the present administration conducted an exhaustive analysis of the activity and confirmed that it could operate best in the Office of the Secretary rather than in one of the bureaus and on October 8, 1953, Secretary McKay assigned the responsibility for the program to the Assistant Secretary for Water and Power Development. It now operates as a part of his office.

Referring to the chart appended to this statement: A group of nine eminent leaders of educational, scientific and industrial organizations provide the Secretary with advice on broad policy matters relating to the new activity. The advisers

provide this service without cost to the Government, except for occasional travel expenses. I am pleased to report that all of the nine original advisers are continuing to serve in this capacity. They are—

Dr. Robert G. Sproul, president, University of California, Berkeley
Dr. Lee A. DuBridge, president, California Institute of Technology
Dr. George D. Humphrey, president, University of Wyoming
Dr. Louis Koenig, associate director, Southwest Research Institute
Mr. Henry J. Schmitt, editor and publisher, Aberdeen (S. Dak.) American-News
Mr. J. J. Cronin, vice president, General Motors Corp.
Dr. Frederick L. Hovde, president, Purdue University
Mr. Sheppard T. Powell, consulting engineer of Baltimore, Md.
Dr. James R. Killian, Jr., president, Massachusetts Institute of Technology

A 2-day meeting of the advisers was held in April 1954. Their recommendations made at that time appear in the appendix to this statement.

A Saline Water Conversion Committee (departmental); consisting of one representative each from the Office of the Assistant Secretary for Water and Power Development, the Bureau of Reclamation, the Bureau of Mines, and the Geological Survey; provides advice and assistance in such matters as development and review of the program, exchange of information, and preparation of the annual reports.

The research is continuously coordinated with private organizations and other Government agencies, including the Department of Defense in accordance with section 3 of Public Law 448, and the National Science Foundation with which a cooperative agreement exists. A copy of the agreement is appended to this statement. Other governmental organizations with which cooperation has been established include the Atomic Energy Commission, the Smithsonian Institution, Federal Civil Defense Agency, the Department of Agriculture, Department of State, the Foreign Operations Administration, and Department of Commerce.

The responsibility for the management of the program including both the coordination activities and the direction of the widely diversified contract research is that of the program director and his staff.

Panels of consultants provide highly specialized scientific assistance in such ways as evaluating proposed research and final results, making technical analysis of existing processes and numerous others.

At present all of the actual research and development is performed by the contractors.

This organization has proved adequate except for some difficulty in obtaining qualified scientific assistance in this highly specialized work, as is necessary to supervise the contract research, assure continuing interest and a flow of new ideas which are still very much needed, and handle the technical and administrative actions in connection with dispersed research of this kind.

II. PROGRESS

At the beginning of the program, the cost of converting sea water to fresh water by the best existing processes—the distillation process with relatively small units—was estimated at about $5 a thousand gallons, or some $1,500 an acre-foot, and it was estimated that if much larger plants of this type were built, also using existing principles, the cost would be $1.25–$1.50 a thousand gallons ($400 to $500 an acre-foot). Two arbitrary cost criteria were set for the initial phase of the program, one for water for municipal and similar purposes at about $100 to $125 an acre-foot, and one for irrigation water at about $40 per acre-foot. They were believed, on the basis of data then available, to represent about the maximum that could be borne by these types of use in continental United States. This is maximum—not average. It was felt that if these goals could be approached or reached, further intensive research and development would be justified to reduce costs. Although considerable work remains to be done before those initial goals are fully realized, they are being approached and it is believed will be materially lowered if the research and particularly the development work is continued.

Because this disparity between the existing costs and the objectives was very large, and because improvements in the few existing processes had almost ceased to occur, it was necessary in the beginning to consider every possible solution to the problem, however remote the chances of success might seem originally. The first step was the preparation of as nearly complete outline of possible processes as could be conceived, as shown in the brochure entitled "Demineralization of Saline Waters," pages 5, 6, and 7. It will be seen that most of the conceivable physical (p. 5), chemical, and electrical processes (p. 6) and energy sources needed

therefor (p. 7) are listed. Those pages and the introductory matter thereto on pages 1–4 of the brochure are included in the appendix to this statement.

This brochure was sent to several hundred scientific organizations and individuals believed qualified and interested in considering the subject, with the request that proposals for scientific research in accordance with the outline, or on any other processes not included there but relating directly to saline water conversion be submitted. It was recognized that eventually some processes would be eliminated as unfeasible, some would be developed through various stages, and in some no interest might exist, yet they should be explored. This has been the result today—several processes are being advanced rapidly, several have been eliminated as unfeasible, and with others in which no voluntary interest has been expressed it will be necessary to carry out some research on a purchase basis in order to exhaust the list.

Results so far confirm this approach, and indicate clearly that no single process will provide fresh water for all purposes at all locations and under all circumstances. Thus it is desirable that several different principles, processes, and combination of processes be investigated and developed concurrently. Furthermore, it would certainly not be desirable to place all reliance on one or two processes to the exclusion of others when none has so far reached the final low cost necessary.

Good results are being obtained and it now appears that in time conversion of both brackish and sea water will be feasible. Twenty-four research and development contracts have been let, several have been completed, and 7 or 8 very promising results have been obtained. One process is being field tested and two others show sufficient promise to justify field tests in a year or earlier. A list of the 24 contracts which have been let, and of some prospective future contracts is attached to this statement.

Some of the more outstanding processes being developed under the program will be discussed later in this hearing by the representatives of the contractors in charge of the several activities. At this time a few of the results can be summarized.

Electric membrane processes

At the time the program began, work had already been underway first in Europe and later the United States on methods of using synthetic resin membranes with electric current to purify industrial fluids, such as sugar solutions. Later, this process was investigated in Holland and England for desalting water, and in 1950 two American groups began limited research work on membrane processes for this purpose.

Some members of this committee will recall that reports concerning the economies of one such membrane process appeared in the press shortly before this program was authorized. As a result of laboratory tests on the small 1952 unit which had been developed previously by Ionics, Inc., the cost of desalting a certain slightly brackish South Dakota water for irrigation uses was estimated to be about $16 an acre-foot.

After the program was started, the equipment was improved and enlarged, and a subsequent contract for laboratory testing a larger unit resulted in a much lower cost for purifying the same South Dakota water—about $4 an acre-foot. Under that same contract a more saline water from Arizona was tested on the improved equipment. This water was about 4 times as saline as the South Dakota water. Based on the tests it was estimated that the cost of purifying that water would be about $20 an acre-foot.

These promising results obtained in the laboratory on brackish waters warranted the field testing of this one firm's equipment. This is being done under contract in Arizona and South Dakota. Overall costs of producing water are progressively being reduced. However, much improvement of membranes and cell design is necessary. Because of the complexity of membrane research, and the limited number of scientists actually experienced in this field either in this country or abroad, it would be almost impossible to have too much work going on in this field. Research on membranes is being carried on at Brooklyn Polytechnic Institute under the program, and independently by Rohm & Haas Co. of Philadelphia, Permutit Co. of New York and Gulf Research & Development. Those firms, especially the first have been very generous in sharing information on their work with the program.

Vapor compression distillation

At the time of the initiation of the program the concensus of those familiar with vapor compression distillation development, particularly that which occurred during World War II, was that major reductions in the cost of producing water

by this process were no longer possible. They believed that any future improvements could only be of a minor nature. After the program got underway it was discovered that this view was not universally held and that numerous scientists and engineers believed that new approaches to the basic distillation processes might result in substantial cost reduction. This proved definitely to be the case, and it was found that during the past 10 years essentially no major improvements had been made in this—the best existing process.

Accordingly, a number of research and development contracts have been undertaken under the program for research on various aspects of the vapor compression distillation process. The contractors include the Badger Manufacturing Co., Yale University, Heinz Engineering Co., and the W. L. Badger Consulting firm.

The possibilities of obtaining fresh water from sea water at a price which might be afforded by municipal or industrial users have been greatly enhanced by the development of the Hickman still. Although yet in its infancy, this process, being investigated by contract with the Badger Manufacturing Co., of Cambridge, Mass., may make possible production of fresh water from sea water for about one-fourth the cost of distilling sea water by the most economical process in use at present. Field tests at some seashore location are being planned. Dr. Hickman will discuss this process in some detail later in this hearing.

Research under the direction of Prof. Barnett F. Dodge and Harding Bliss at Yale University also seeks to bring down the cost of vapor compression distillation by increasing heat transfer rates in the evaporation units. The approach has been the use of forced circulation coupled with dropwise condensation of the water vapor. Encouraging results have been reported.

The Heinz Engineering Co. has attacked the problem of finding the proper balance of design factors so that particular vapor compression distillation systems can be arranged to operate at maximum economy. The work includes development of design and cost data on vapor compression distillation plants with compressors driven by steam turbines exhausting into the vapor compression cycle.

Dr. W. L. Badger of Ann Arbor, Mich., is investigating the use of vapor compression distillation in combination with multiple-effect evaporation. Preliminary estimates by the contractor indicate that by this method large-scale demineralization costs can be reduced appreciably below present-day costs by conventional means using either process separately.

Solar distillation

The role which power or energy plays in the entire conversion situation is of extreme importance. For processes using an external energy supply the cost of the energy alone for converting sea water will be, at the minimum, in the order of $20 per acre-foot (at 5-mill power). Dr. Murphy will discuss this minimum energy requirement briefly later in these hearings. Because of this need for energy it becomes important that nonconventional low-cost energy such as solar energy, windpower, geothermal energy, etc., be explored vigorously and exhaustively in connection with process development and use. The use of solar energy to extract fresh water from sea water is also attractive from the viewpoint of conservation of fuels. To become more attractive economically, lower cost equipment of greater efficiency is needed. Research is being carried out in an effort to discover ways and means of bringing about those improvements. Such research includes basic designs by Dr. Maria Telkes of New York University and Dr. G. O. G. Löf, Denver, Colo., use of plastics to reduce costs by Bjorksten Laboratories of Madison, Wis.

Critical pressure devices

Separation of fresh water from sea water at pressures of 4,000 to 5,000 pounds per square inch pressures at temperatures in a 700° to 800° F. range appears attractive energywise in a large scale. This principle of separating salt water was suggested earlier by the Swedish inventor Baltzar von Platen who also is given credit for having invented the Electrolux refrigerator. Von Platen and his associates stopped work because of problems now believed to be solvable, namely, corrosion and scale formations. Research is underway at Nuclear Development Associates, White Plains, N. Y., to determine the technical feasibility of the method. Two of the problems to be solved are these of corrosion and scale formations at these high temperatures and pressures.

Osmotic processes

A different way to use membranes to desalt water is by use of hydraulic pressure. Although theoretically possible, it was not until research workers at the University

of Florida, under a program contract, discovered the right type of membranes that technical feasibility could be demonstrated. The work, so far, has been on a very small scale, in the laboratory and much remains to be done to develop a practical process. However, the results so far are encouraging.

Another approach to use of these principles is being investigated at the University of California at Los Angeles.

Still another method in this field which may prove to be very important is that proposed by Dr. Murphy, State University of New York. He is developing an osmotically power permselective membrane device using the energy of the sun instead of electrical energy.

Solvent extraction

There are possibilities for using solvents to take fresh water out of salt solution and leave the salt in the brine. Exploratory research at the Texas A. and M. Research Foundation has shown that solvents of that type do exist and that their properties make possible a technically feasible process for obtaining desalted water. Additional research is being planned to determine whether economic feasibility appears possible.

Separation by freezing

Ice frozen from saline water contains much less salt than the original water. Although basically promising an economical method of separation by freezing has never been developed, because of numerous practical difficulties. Research at the Applied Science Laboratories, State College, Pa., and at the University of Washington at Seattle is now being carried out under the program in an effort to overcome these difficulties.

III. NEED FOR EXTENSION AT THIS TIME

The question may reasonably arise now as to whether an extension of the authorization period is desirable at this time, rather than at the close of the present 5-year period. One answer is this:

Under the provisions of the present act, all of the actual research under the contracts, all reports thereon, and all correlation and coordination of data must be completed by July 15, 1957.

Most research and development contracts are for a period of about a year. Thus it would be necessary to terminate most contracting by about December 1955, 10 months hence, to permit completion of the work under the contract by December 1956, and final reporting of the results and conclusions of the program 6 months later. Thus scarcely any of the appropriations for fiscal year 1957 could be utilized for contract research just at the time when the need for advanced research and development of promising processes is expected to be felt most. Moreover, research of this type is perforce, long range in character. Unless assurance can be given to the private firms and research organizations and particularly to individual private scientists whose ideas are needed that promising studies will be carried to completion, we anticipate difficulty in securing interests of scientists, and in achieving worthwhile results even in fiscal years 1956 and 1957.

Interruption or abandonment of the program after fiscal year 1957 would dissipate a large part of the valuable results already achieved or anticipated, with a consequent loss to the Government.

Furthermore, after 2½ years of work, it is now possible to foresee with greater assurance the chances of success of the entire program.

IV. NEED FOR SOME RESEARCH BY EXISTING GOVERNMENT LABORATORIES

The authorization in the proposed legislation to permit an expenditure up to $500,000 for research to be conducted in existing Government laboratories would prove advantageous in a number of ways. Several individual private scientists in private life have had ideas on processes worthy of at least exploratory research effort. However, they do not have laboratory facilities available. Some would be agreeable to having the research carried out at a Government laboratory, but in the absence of specific authority that has not been done. Thus the research has not been carried out. Then there is the situation where Government scientists themselves have worthwhile research to propose, which they and their laboratory are best qualified to perform. Another area in which operations in a Government laboratory are valuable is in making unbiased comparisons of processes and in confirmation of research results. In some cases, Federal scientific organizations offer the only satisfactory personnel and facilities to conduct certain investigations.

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V. NEED FOR INCREASED AMOUNT OF AUTHORITY AND THE 25 PERCENT ADMINISTRATIVE EXPENSES

As provided in the proposed amendment additional funds would carry forward the development of processes. It is usually necessary and desirable that the initial research on development of a process be conducted on a relatively small scale laboratory basis. For such research only nominal expenditures have been required. Although much of this exploratory research needs to be continued, it was not considered to be the purpose of the program to limit the activities to basic, exploratory, or laboratory research. To accomplish the purposes of the act in developing processes on a scale sufficient to determine the feasibility of the development "on a large-scale basis," pilot plants or field tests become necessary as individual processes which show sufficient promise are developed in the laboratory. Such tests are essential in order to obtain reliable cost estimates and information on the durability of the unit and critical parts, down time, production capacity, power requirements, etc. Developmental work, including field tests of this type, is much more costly than laboratory investigations. However, nearly all such work is handled on a cost-plus-fixed-fee basis. Therefore, if it is adequately inspected and audited no unnecessary expenses are involved. I cannot emphasize too strongly the need for adequate inspection by qualified Government scientists, of all Government contract research work.

The proposed authorization for appropriation of a total of $1,500,000 for departmental expenses is only a small increase on a per year basis of the amount authorized under the present act. From this fund would come not only departmental expenses for the 1953–63 period, but also for the additional 2-year period for completion of research projects and for the final 1-year period for correlating, coordinating, and rounding out the results. It is expected that the small increased rate (from $100,000 a year to approximately $115,000) will cover the increased activity and the resultant increase in coordination and in supervision functions. Particularly as each process reaches the larger field testing stage is constant inspection needed. It has already been clearly shown in the one field test under way that personnel of high caliber, capable of discerning successes, failures, and pitfalls and able to recommend changes in direction, must be on hand in addition to the skilled personnel of the contractor.

GENERAL

Every effort is being made to encourage private development of processes and as a result a few industrial firms have undertaken independent research in this field during the past year, and wholehearted cooperation has been received from several organizations now engaged in these activities. It is entirely possible also that some industrial firms may be working on processes without advising the Department of their activities.

In addition the work is being coordinated with that abroad, as it is believed to be essential that every scientific improvement or facility to solve this pressing national problem be brought to bear, wherever such assistance may be. Program scientists and consultants are obtaining technical assistance from abroad both by correspondence and by personal visits. The latter have proven to be extremely productive. It is planned to continue such exchange of technical assistance and cooperation wherever it is clearly of advantage to the United States program to do so.

Mr. JENKINS. Since this is the first meeting we have had with the committee since the program was started in 1952, it was thought that the committee might like to know quite briefly about the organization in the Department that is handling the work.

If I could refer to the chart that is attached to the material that has been supplied to the committee members, the responsibility for the program is that of the Assistant Secretary for Water and Power Development. Then the group of nine advisers to the Secretary from educational, scientific and industrial organizations provide advice on the broad policy matters. We do not ask them for much advice on the details of processes. They, like Mr. Powell, are men of considerable eminence. Five are university presidents.

At this point I would like to attempt to answer 1 question that was asked a moment ago about the view of the other 9 advisers.

Shortly before this legislation was introduced, letters were sent to the nine advisers asking them for their views. We have now received 7 replies from the 9. All are very heartily in favor the extension of the legislation. They do not have copies of this bill. They are merely commenting on the principle of extending a research program which has just begun.

With your permission, I should like to insert those seven responses in the record.

Mr. ASPINALL. Do you have them with you?

Mr. JENKINS. Yes, sir.

Mr. ASPINALL. Present them to the professional staff member.

(The documents were handed to Mr. McFarland.)

Mr. ASPINALL. As I understand it, Mr. Jenkins, these advisers of whom you have been talking are not paid and do not even get a per diem allowance. Is that correct?

Mr. JENKINS. That is correct, sir. We pay their travel expenses to a meeting if we ask them to attend one.

Then, referring still to the chart, a saline water conversion committee within the Department consists of one representative each from the office of the Assistant Secretary for Water and Power and from the Bureau of Reclamation, the Bureau of Mines, and the Geological Survey.

Then you will see that the research is coordinated—I believe this question was asked earlier—is coordinated with numerous other agencies of the Government as well as with private industry. Very active coordination is maintained with the Atomic Energy Commission and these other departments, all of whom have some interest in this program.

Of course, the responsibility for the management is that of the Director and his staff. Panels of consultants provide technical assistance. They are really the staff of this organization, the technical staff on whom we call occasionally.

Then at present all of the research is handled by means of contracts and grants.

Now the second subject I wanted to discuss is the progress to date, and I judge that the committee is most interested in that subject.

At the beginning of the program the cost of converting sea water by the best existing processes was about $1.25 to $1.50 a thousand gallons, or about $400 to $500 an acre-foot. The cost of the water at the plant in California that was mentioned earlier has been computed at about $650 an acre-foot.

For this reason, 2 arbitrary cost goals were set for the initial phase of the program, 1 for municipal and industrial water at about $125 an acre-foot, and for irrigation water at about $40 an acre-foot. These were maximum costs, not average, of course. It was felt that if they could be approached further research would be justified. If they could not be approached in this earlier period, then we would know at the end of the 5 years.

Although much remains to be done, the first of these goals is being approached at present.

The CHAIRMAN. You are referring to the cost of industrial water?

Mr. JENKINS. The cost of converting water, yes. The first of the goals, the industrial water at $125.

The CHAIRMAN. You are approaching $125 on industrial water?

Mr. JENKINS. Mr. Engle, we are approaching $125 on converting water, whether it would be used for industrial purposes or irrigation or any other purpose.

The CHAIRMAN. And that is from a start of $1,500 an acre-foot?

Mr. JENKINS. A start of $400 to $500 an acre-foot. The small stills that were in operation at the beginning of the program would produce water at about $1,500 an acre-foot, and it was rather carefully computed that if such processes were developed in a large-scale basis the water would cost $400 to $500 an acre-foot. On that same basis, as well as we are able to extend the laboratory results now, we believe that if large plants were built the cost might be as low as $125 an acre-foot.

Mr. RHODES. Mr. Chairman?

Mr. ASPINALL. Mr. Rhodes.

Mr. RHODES. What process are you using to get the $125 cost?

Mr. JENKINS. Two distillation processes, if the laboratory research solves certain problems that now are rather great.

Mr. RHODES. What about the membrane-ion process? Does that appear to have promise?

Mr. JENKINS. These figures that I have given refer to distillation in general, and the membrane-ionic process is one which is most adaptable to the brackish waters.

I had hoped earlier to have time to go into a little of the history and discuss the needs for improving many of our inland brackish and saline waters as well as ocean water. The program is devoted to both purposes, and much of the research contributes to both purposes.

The ionic process that is under field test in Arizona at present is most suitable for treatment of the slightly saline waters. Some estimates have been made of the cost of demineralizing sea water by that process, and it would be very high.

Mr. RHODES. Do you have any interim report you might make as to the success of this field test in Arizona?

Mr. JENKINS. Mr. Rhodes, that test is just getting started. The first tests were begun about the 10th of January. That was what we call a shakedown test. Naturally a number of problems arose. We expected them. And the second test of about 6 weeks is getting under way now. We do not have the results. We have learned a few things, one that is very important—that each water that is used in that process presents a different problem. We are finding some major scaling problems with the Arizona water due to a very small amount of iron in the water.

This emphasizes the contention that the firm has always made that a different set of computation and research will be necessary for almost each different water until we get some of the problems solved. It must be recalled this is a very new subject and a very new process.

Mr. RHODES. Are you having difficulties in disposing of waste materials? I understand that is a problem also.

Mr. JENKINS. Mr. Rhodes, that will be a problem in any inland area, and for that reason the quantity of the waste drain is a very important factor. In other words, if 90 percent of the water can be

rectified and 10 percent can be wasted, we will have not only a smaller disposal problem but we will have more water to use.

In this particular case, I may say that while we had thought that would be about the ratio that would result from this process, it is showing instead about 60 percent product and 40 percent waste. That is another matter we have to work out. It is just one of those things you do not get in the laboratory.

Mr. ASPINALL. You may proceed, Mr. Jenkins.

Mr. JENKINS. Then, in addition to the electrical membrane process, which will be discussed tomorrow at more length by Dr. George W. Murphy of New York State University, who has made a very extensive study of membrane processes in general, both in Europe and in the United States, we have a rather attractive process in a critical pressure distillation system which was originally proposed by the Swedish scientist Von Platen. That process is being developed under the program and the initial results show that if three rather major problems can be solved, we may be able to produce water there by that process at somewhat less than $100 an acre-foot. We are still a long way from a pilot plant on that.

Dr. Laserson, one of the principal scientists engaged in that contract research, is here today and he will be able to discuss that process at greater length tomorrow.

Then another: Preliminary results from one vapor compression distillation investigation indicates a very good possibility of producing fresh water from sea water for approximately one-fourth of the cost of water by any process in use when the program was started. This is an ingenious process. It was mentioned earlier as having a rotating mechanism. It was invented and developed by a scientist of considerable accomplishment, Dr. Kenneth C. D. Hickman, who will appear before the committee tomorrow and discuss that development.

Then I wanted to say that another very potential field is that which was mentioned this morning in solar distillation. The program so far has shown, among many other things, Mr. Chairman, that electric power or other energy is a very important factor in any conversion process. Not only must we have the electrical energy and pay for it, but if the conversion job is a large one it means finding a large block of electrical energy some place. That cannot be overlooked.

For that reason, much importance is being attached in the program to processes using solar distillation or other nonconventional energy sources. Several small experiments are underway in this field in Colorado, Wisconsin, California, New York, and in several areas abroad. Dr. Maria Telkes from nearby New York University will summarize that work on behalf of the other contractors who are at a greater distance tomorrow.

Then there are other promising processes that are being developed: One at Texas A. and M. Research Foundation; freezing processes at State College, Pennsylvania, and at the University of Washington, Seattle; and an osmotic process at the University of Florida and the University of California at Los Angeles.

That concludes my remarks regarding process development and progress. I have three other short subjects.

Mr. ASPINALL. How long will it take, Mr. Jenkins, on the other ones? Will it take you over 5 minutes on each one of them?

Mr. Jenkins. Five minutes altogether, perhaps.

Mr. ASPINALL. Then you may proceed. We will try to get your general presentation, and then tomorrow morning we shall have you before the committee, you and Mr. Frye, for immediate questioning as we start our proceedings in the morning.

Mr. JENKINS. The third subject that I wanted to mention was the need for the extension of the authorization at this time rather than later at the end of the 5-year period.

Mr. Frye has mentioned the solicitor's opinion which has been placed in the record. Most of the research contracts are for about a year. Under the present act all of the research would have to be finished by July 15, 1957, and, therefore, it will be necessary under the present act to stop all contracting, or most contracting, by about December 1955, some 10 months hence, in order to permit the completion of the contract work in the year and final reporting 6 months later in July 1957. This would be just at the time when the developments are showing the greatest promise and requiring intensive research and development.

Also, and possibly more serious, the flow of new ideas will definitely diminish if the program is being terminated, and the greatest need is for new ideas. We do not believe, and I think I would be amiss if I conveyed to the committee the impression, that the 3 or 4 processes on which we are working can now be isolated and all work can be concentrated on them. That would be placing all of our eggs in 2 or 3 baskets.

The next subject I had is the need for the increased amount of the authorization.

Most exploratory research has been, and will continue to be, necessary. Such research requires only small expenditures. However, to accomplish the purposes of the act in developing processes on a large-scale basis as required in the act, field tests, properly referred to as pilot plants, are necessary. These are pilot plants. They are not demonstration plants. They are merely pilot plants, but they cost more than laboratory research. Each one will cost, we estimate, from $100,000 to $300,000 or $400,000, and there may be 8 or 10 necessary during the program.

Mr. Powell mentioned that later then demonstration plants, by someone—we hope it will be private industry—may be in order.

I thought I should mention the 25 percent limitation on the administrative expenses as provided in the amendment. That is the same percentage as in the present act. The proposed authorization for $1,500,000 for that purpose is only a small increase on a per year basis of the amount authorized at present.

The small increase from $100,000 to about $115,000 a year would provide for the increased research activity and the resultant increase in coordination and in supervision functions.

Particularly as each process reaches the larger field testing stage is constant inspection necessary. It has already been clearly shown that in the one field test under way personnel of a high caliber, capable of discerning success, failures, and pitfalls, and able to recommend changes in direction, must be on hand in addition to the skilled personnel of the contractor. This is no different than building a dam, in which we must have our inspectors on the job.

The last subject which I had is the need for some research in existing Government laboratories.

The authorization in the proposed amendment to permit an expenditure of $500,000 for research in existing Government laboratories should prove advantageous in a number of ways. Several individual scientists in private life have ideas on processes worthy of at least exploratory effort. However, they do not have laboratory facilities available, and so far efforts to get them located in universities have been unsuccessful. Some of these people would be agreeable to having the research carried out in a Government laboratory, but in the absence of specific authority that has not been done and the research has not been carried out.

Then there is a situation where Government scientists themselves have worthwhile research ideas to propose, which they and their laboratory are best qualified to perform.

Still another area in which operations in the Government laboratory are valuable is that in making unbiased comparisons of processes and confirmation of the reported research results.

That concludes my statement.

Mr. ASPINALL. Thank you very much, Mr. Jenkins.

Mr. Jenkins has asked that certain statements be placed in the record, the statements of Dr. Powell, Dr. DuBridge, Dr. Koenig, Dr. Schmitt, and Dr. Sproul. The Chair will advise his colleagues he has examined these statements and they are generally in accord with the statement made by Mr. Jenkins in reference to them, and they support the bill. Also the statement of Dr. Hovde.

Is there any objection?

Hearing none, it is so ordered.

(The documents referred to follow:)

PURDUE UNIVERSITY,
Lafayette, Ind., February 15, 1955.

Hon. FRED G. AANDAHL,
Assistant Secretary of the Interior,
Washington, D. C.

My dear Mr. SECRETARY: I have discussed the saline water research program of the Department of the Interior with various members of the Purdue University staff. I join them in the opinion that this program has been a most worthwhile one and that it would be highly desirable to continue the research beyond the present expiration date of the act supporting this program. The gradual diminution of our basic water resources poses a serious future threat to all aspects of our economy. It is self-evident that a vigorous research program concerned with the recovery or production of potable water from both sea water sources and available brackish water sources is one of the most promising methods of insuring adequate future water supply.

There are several current research projects of your saline water conversion program which show promise of bringing at least a partial solution to the problem. In addition, the mere existence of this program serves to call to the attention of the scientists of the country the need for further research in the solution of this most pressing need of the country. The great need for this program is the generation of new ideas. The greatest probability of generating these new ideas is through an active research program. Certainly conservation of water resources through research is an appropriate area for support by the Federal Government.

I should be most pleased, therefore, to go on record as favoring the extension of the present act for a period of 5 years with an additional year to evaluate the results of the research program.

Yours sincerely,

FREDERICK L. HOVDE,
President.

FEBRUARY 12, 1955.

FRED G. AANDAHL,
Assistant Secretary of the Interior,
Washington, D. C.

The saline water conversion program is examining all lines of approach to this important problem. Though there are attractive possibilities it is clear that an extensive program of research is still required before practical methods of water rectification can be achieved. I would strongly urge a continuation of the authority for the program with continued careful evaluation of its progress and of proposals for future expenditures.

S/ L. A. DUBRIDGE,
President, California Institute of Technology.

SOUTHWEST RESEARCH INSTITUTE,
San Antonio 6, Tex., January 6, 1955.

Mr. FRED G. AANDAHL,
United States Department of the Interior,
Washington, D. C.

DEAR SECRETARY AANDAHL: I have your letter requesting comments on the proposed extension of the Saline Water Conversion Program Act for an additional 5 years.

In the chemical industry it is generally accepted that the average time from conception to marketing of a new product is approximately 7 years. For the more complicated or advanced products or processes the development time is, of course, even longer. The saline water program is developing a major new chemical process in an extremely difficult field and it is only to be expected that more than 5 years will be required.

In July 1953 in one of my speeches on saline water conversion, I estimated that it would take 5 years to develop processes economically useful on brackish waters and to determine whether or not sea water reclamation would be feasible—also that if proven feasible it would then take another 10 years before sea water conversion plants were in successful operation.

In another speech first given in July 1954, I indicated that progress had been better than previously anticipated but that it would still be 3 to 4 years, i. e 1957–58 before feasibility were shown. Transcripts of both of these talks with the pertinent passages marked in red are enclosed.

Although the progress in the last 6 months has been satisfactory there is nothing to indicate that this time schedule can be appreciably shortened. This means that by the end of the present act, we will probably know whether sea water reclamation will ever be feasible. It will then take us at least the additional 5 years requested in order to fully develop a feasible process.

I do not believe that the legislature can question the amount of research expenditures under the act. Actually out of every $14,000 spent annually for research and development in the Nation—only $1 goes for the research effort of the saline water program. Or to put it another way, out of every $9,000 spent by Government agencies for research and development only $1 is spent on the saline water conversion research effort. This despite the judgment of many that, after defense, water is the No. 1 problem in the Nation's welfare.

Cordially yours,

LOUIS KOENIG, *Associate Director.*

JANUARY 10, 1955.

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior,
Washington, D. C.

MY DEAR MR. AANDAHL: It is with interest and satisfaction that I note that it is the intention of the Department of the Interior to recommend to the Congress the extension of the Saline Water Act of 1952 for a period of 5 years.

To suspend this work late next year would, in my opinion, be a serious setback to the solution of this problem which is vitally necessary to the future welfare of the Nation. Each year water shortages in parts of our country, as well as elsewhere in the world, increase in gravity. In many cases converted saline water appears to be the only remedy for these conditions.

For many years desalting of water in arid or semiarid regions has been discussed pro and con. Usually, comments or proposals have lacked in practicable application and often have been oblivious to the vital matter of cost of production.

In my judgment, the Department of the Interior has approached the problem in a realistic manner and has developed methods of attack which will in time prove successful. Few who have seriously thought on this problem will minimize the difficulties which must be overcome or the time which will be required to find a satisfactory answer, but it is equally true that few will doubt that the time will come when water from this source must be widely used in our country.

I am sure that many will join with me in the hope that this program will be placed on a permanent and continuing basis.

Sincerely yours,

SHEPPARD T. POWELL,
Consulting Engineer.

THE UNIVERSITY OF CALIFORNIA,
January 31, 1955.

Re saline water conversion program

Mr. FRED G. AANDAHL
Assistant Secretary of the Interior,
Department of the Interior, Washington, D. C.

DEAR MR. AANDAHL: In reply to your letter of January 4 concerning a 5-year extension of the Saline Water Act, and following a conference with Prof. Everett D. Howe, it would seem to me that the progress of work to date and the prospect of getting significant research fully underway would warrant the proposed extension.

It was a source of satisfaction to learn that you also believe that results obtained thus far are sufficiently encouraging to indicate that economical conversion will be developed, provided research and development activities are given a reasonable time in which to cope with this significant problem. While some may be deluded into believing that research is simply a process of waving a magic wand, or its results can be assured merely by the size of appropriations or the urgency of deadlines, I am happy that there are those who realize that it is a human process warranting not only the economical marshalling of the best brains of the Nation, but also requiring careful programing, precise knowledge of developments, and many tedious man-hours of the most exacting type of human endeavor—spurred by faith in the promise of results and not by any guaranty, man-given or otherwise.

I commend you and your colleagues for the recently completed mission to inspect research and development in water conversion throughout Europe and northwest Africa, and I am happy that our Professor Howe was privileged to participate as a member.

Yours sincerely,

ROBERT G. SPROUL.

ABERDEEN AMERICAN-NEWS,
Aberdeen, S. Dak., January 7, 1955.

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior
Department of the Interior, Washington, D. C.

DEAR MR. SECRETARY: I have your January 4 letter and am in complete accord with the decision to recommend that the Congress be requested to extend the present Saline Water Act of 1952 for a period of 5 years.

It is my personal observation that more and more people have become aware of the water shortage looming in various sections of the United States and it seems to me that this problem now has become a paramount one which must be resolved.

With kindest regards,

Yours very truly,

HENRY J. SCHMITT, *Editor and Publisher.*

58839—55——4

THE UNIVERSITY OF WYOMING,
Laramie, Wyo., January 7, 1955.

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior,
Department of the Interior, Washington, D. C.

DEAR MR. AANDAHL: I agree with your proposal that it would be a good idea to extend for another 5 years the Saline Water Act of 1952 which expires July 15, 1957. I am of the opinion that considerable progress has been made and if the project is not extended much of the effort which has been expended would be lost.

Please call upon me if I may be of any service to you in securing passage of legislation extending the original Saline Water Act.

Sincerely yours,

G. D. HUMPHREY, *President.*

Mr. ASPINALL. We will hear from Mr. Sheppard T. Powell, Consulting Engineer, Baltimore, Md. Proceed, Mr. Powell.

STATEMENT OF SHEPPARD T. POWELL, CONSULTING ENGINEER, BALTIMORE, MD.

Mr. POWELL. Mr. Chairman, I appreciate the compliment and the privilege that you have extended to me. Thank you.

I have a prepared statement.

Shortly after Congress authorized the saline water conversion program, I was requested by Secretary of the Interior Oscar L. Chapman to serve as 1 of a group of 9 advisers to assist the Secretary in carrying out the provisions of Public Law 448, with regard to the human, economic, and industrial phases of the project. Subsequently, the writer and the other members of the advisory group have continued to serve Secretary McKay in this capacity. In this way, we have been kept informed of the general progress of the program.

When the program was initiated, many were skeptical of the merits and justification of such scientific studies. However, this attitude has been greatly altered and the program now has the cooperation and support of recognized men of science and many agricultural and industrial groups throughout the country, in addition to similar organizations outside of the United States.

It is the speaker's opinion that the organization, development and direction of the program have been, in general, satisfactory, with the possible exception that desirable close contacts with prospective research contractors have been limited because of the small size of the technical staff administering the program. With a few additional scientific employees, it would be possible to exchange and stimulate ideas more fruitfully, and to follow more closely the research projects to be carried on in the future. This is important because of the widely diversified nature of the research assignments and because many of the leading authorities in the various phases of the research are located considerable distances from one another and from Washington.

It is a fact that research and development of new processes are frequently tedious and subject to alteration from time to time. After reviewing the results of the saline water program to date, the speaker is of the opinion that the progress has been exceptionally good and has resulted in the assembly of many fundamental data necessary for evaluation of various processes for demineralization of saline water.

The foundation is being laid for realistic development of practical conversion processes. Several schemes have shown enough potential merit to justify the next step in the program. Provision should be made soon for construction of pilot plants of appropriate size to be operated under actual conditions to check laboratory findings. Data acquired will lead ultimately to full-scale installations, preferably by private industry.

I have discussed this program with many people throughout the United States and find that there is very keen interest and much hope that, through continued research and development, practical conversion processes can be developed. There is particular need for conversion of saline waters in many areas where fresh water supplies are inadequate for present or future requirements.

Many phases of the saline water program must be considered. Accurate appraisal of the relationship between saline water conversion and water requirements must be preceded by the acquisition of intimate knowledge of the quantity and quality of water needed for various uses. For industries, not only overall requirements must be determined, but also those of the component process steps in which variations in quality are permissible. The existing costs of water used for various purposes within each type of industry should be investigated so that the tolerable costs of converted saline waters can be estimated. The economics of water use must always be in the forefront when considering converted saline water as a substitute for or supplement to fresh water supplies.

Any long-term program for saline water conversion must include provisions for locating and evaluating existing sources of both fresh and saline waters. Information needed on these waters must include their geographic location, quantity, and quality, and their potential adaptability for varied requirements, with or without some form of water conditioning.

In many cases, it will not be necessary to completely demineralize the saline water. Desalting for any use should aim at the minimum quality which will meet the specific need. For some industrial uses, untreated saline water may be satisfactory, provided equipment is constructed of corrosion resistant materials. For others, partial demineralization may be used to advantage, or complete conversion of part of the supply followed by blending with untreated water to obtain the various water qualities necessary for different uses. In many cases, irrigating water can also be blended in this manner. Where raw water salinities vary, desalting methods may be necessary part of the time; during the remainder, conventional methods of water treatment may suffice.

Economic demineralization of saline waters would result in many tangible and intangible benefits. Because of industry's and agriculture's interests it now seems timely that cooperative efforts by Government, industrial management, and agricultural organizations should be fostered, especially for pilot plant water conversion installations. Such effort will depend upon congressional authorization for continuation of the saline water conversion program.

The research and development now in progress is being watched with much interest by those engaged in similar projects in a number of foreign countries. Cooperation between this Government and those abroad having mutual interests in this problem should be fostered

and expanded. This may be best accomplished by a specific program of exchange of data and personal inspection of installations in this country and in foreign fields. The Division of Social and Economic Affairs of the United Nations is urging that such mutual cooperation be established and developed.

It is desirable that the responsibility in the Federal Government for coordination of the technical aspects of saline water developments rest with one Federal agency, as is done with mining or irrigation. I was glad to learn that quite a number of requests for information on this subject have been received from persons in friendly nations abroad, and that considerable technical data on research in Europe is being obtained by personal contact with scientists there. I know from my own experience that foreign scientists are often abreast or ahead of us here, and I feel that the officials in charge of the program should do more that they have to assure that every useful idea, wherever it arises, be applied to this pressing problem.

To carry out effectively, and to put into practical use, pilot plant, semicommercial plant or full-scale operation will require funds much in excess of those originally authorized in Public Law 448. In view of the great needs for additional water supplies, and the tremendous benefits that will result from successful desalting processes, the financial support for this work has been meager, both here and abroad.

It is the opinion of the speaker that the entire problem of developing and using saline water supplies in this country, as well as elsewhere in the world, should be made a part of national water policy. There are many other facets of water resource development, but to ignore the value of saline water sources and their potential beneficial uses in the solution of the overall water requirements of this Nation would be unwise.

If the program is ended in 1957, the knowledge gained by that time will lose much of its potential value, because the ultimate purpose has been to translate research knowledge into practical application. I, therefore, urge that the necessary legislation be enacted to continue the saline water conversion program for not less than 10 years and that adequate funds be appropriated to accomplish the desired results.

The bill 2126 seems adequate for the present. However, it may be found that individual plants larger than the usual pilot size will be needed to work out plant costs and problems, before private enterprise is willing to take over. If so, such authorizations might be made individually as each process justifies.

Thank you.

Mr. ASPINALL. Thank you, Mr. Powell for a very clear statement.

I understand that your position is that the work cannot be finished within the limitations of 2 additional years. Is that correct?

Mr. POWELL. That is correct.

Mr. ASPINALL. And that perhaps it will take at least 10 additional years; is that correct?

Mr. POWELL. I think so.

Mr. ASPINALL. During that 10 additional year period, it may be advisable to construct and operate pilot plants?

Mr. POWELL. Yes, sir.

Mr. ASPINALL. In order to prove formulas brought out by the laboratories?

Mr. POWELL. That is correct.

Mr. ASPINALL. And when we reach that state, if possible, you would like to see private industry and the Government cooperating on it?

Mr. POWELL. I think that would be the best plan that could be followed as an overall governmental policy.

Mr. ASPINALL. Whenever private industry is willing to take over the program with the answers arrived at by that time, then the Government should get out of the program?

Mr. POWELL. I think so, with the exception that I think the Government should continue for all time, as they have, for instance, in collecting data in the United States Geological Survey. I have a strong feeling that the saline water program in the United States should not be ignored, since we need it as part of our overall water program.

Mr. ASPINALL. Let me ask you this: Has not the United States or some agency of Government been collecting data throughout the years even before this authorization was contemplated?

Mr. POWELL. Yes, they have; but there is still need. There are many blind spots that there is much need now for collecting more data.

Mr. ASPINALL. The Chair recognizes the gentleman from New York for questions.

Mr. O'BRIEN. No questions.

Mr. ASPINALL. The Chair recognizes the gentleman from Utah.

Mr. DAWSON. No questions.

Mr. ASPINALL. The gentleman from Texas.

Mr. ROGERS. Mr. Chairman, I have one question.

Mr. Powell, is there any definite tie-in or possible tie-in later on, do you anticipate, between this program and the Atomic Energy program?

Mr. POWELL. I think there is a very definite possibility of it. If I may, I would like to explain what I mean.

At the present time, energy from atomic energy sources, nuclear sources, is not competitive with other fuels. I believe, however, that the time will come, and is fast approaching, not only here but abroad, where fuel is in short supply. Nuclear power or generation from nuclear power is such that there is a great deal of heat generated, and I believe that that properly worked out will be a source of fuel for obtaining fresh water from salt-water sources.

Mr. ROGERS. Mr. Powell, carrying that on further, there are tremendous requirements for water insofar as the nuclear power development is concerned. That is true, is it not?

Now would there be a definite connection from that standpoint, in other words, the use of water in developing that program further?

Mr. POWELL. I believe that in this country it is not now necessary to go to nuclear energy to convert saline water. I do believe, however, that where this nuclear power is generated and where there is short supply of fresh water that, by properly designing a plant, they can use salt water for many of the sources, and when this is done they would then have the energy to convert such of the salt water as they might need over into fresh water, and by having this energy available it would be byproduct energy. I think there is a great possibility in the future.

I have talked to some of the people in the United Nations about this, and there are certain nations abroad that are not only short of fresh water but they are short of fuel, too. I think there is the greatest possibility of developing a combination or multipurpose projects by the use of this nuclear power and desalting of water.

Mr. ROGERS. Thank you.

Mr. ASPINALL. The Chair recognizes the gentleman from California, Mr. Hosmer.

Mr. HOSMER. Are the other eight members of the advisory board in substantial accord with the opinions you have expressed?

Mr. POWELL. I do not know. I have never discussed with them. I know some of them are. Maybe they all are not.

We know at the present time they have gone on record that nuclear power does not at the moment fit into this country.

Mr. HOSMER. I mean with respect to the statement you made to the committee, the prepared statement.

Mr. POWELL. I think in general that is true. I think they are, as far as I know.

Mr. HOSMER. I just wanted to say on my own behalf—and I am sure the committee feels the same way—that you gentleman have performed a real public service, and we are grateful to you for the time and trouble you have taken to be here today.

Mr. POWELL. Thank you.

Mr. ASPINALL. The Chair recognizes the gentleman from Montana.

Mr. METCALF. No questions.

Mr. ASPINALL. The gentleman from Arizona.

Mr. RHODES. Are you ready at this time to discuss any specific processes for demineralization of saline water?

Mr. POWELL. I would like to make this one general statement on processes, because that question has arisen often—what is the best process to use?

Before you can answer that question or before anyone can intelligently answer that question, they must qualify it by, Where is the water? And where is it located geographically?

For instance, if you are out on the desert and you have plenty of solar energy, which of course you do have from the sunlight, then the processes utilizing solar energy are probably the most practical ones to use. However, there are other sections of the country where you do not have that kind of condition and where you have low-grade fuel and where you can use byproduct and eventually use it as a multipurpose project. Then I think you have got to be guided on the selection of the process which is most satisfactory, depending upon those factors.

Mr. RHODES. I was thinking more in terms of the actual process used in removing the mineral from the water rather than the sources of power. As I understand it, there are various devices which are in various stages of perfection to get the job done. Are you in any position to comment on which appears to be the most promising?

Mr. POWELL. I presume you are referring now to the new development which has come in by membranes and ion exchange?

Mr. RHODES. Yes.

Mr. POWELL. That is in relatively early stage of development. It has enormous potential values as time goes on. That also has some power involved, but a minor amount.

Have I answered your question?

Mr. DAWSON. Will the gentleman yield?

Mr. RHODES. I will yield.

Mr. DAWSON. I would like to inquire of the gentleman from Arizona if the process being used in Arizona is the solar process.

Mr. RHODES. No, it is not at the present time. At least to the best of my knowledge it is not.

Mr. DAWSON. It seems to me with the sunshine you have down there that would be the ideal place to develop the solar process.

Mr. RHODES. I thank the gentleman for his fine comment on the climate of my State.

Mr. ASPINALL. The Chair recognizes the gentleman from Califfornia, Mr. Sisk.

Mr. SISK. Mr. Powell, you mentioned here at the end of your statement that you feel H. R. 2126 seems adequate for the present. Does that infer that you feel that the provision, I believe, of $6 million over the period of 10 years is adequate for such research as may be needed?

Mr. POWELL. Yes, I think it is for the moment. It is as far as you can tell at this time. The laboratory research is not all completed yet. What the present laboratory research has done is to point up all of these processes. They have made a broad survey of all of them. So that I feel from now on they will concentrate on the ones that have the greatest potential merit. That amount of money I think would permit also some pilot-plant installations, the next step.

In any research, you cannot go directly from laboratories into full-sized plants. I think we all recognize that. Those who have tried it have found out the error of their way because they wasted money. So the next step is to put in pilot plants, not only to work out the details of the processes that are being tried out, but also to get design data and cost data and that is the next step. From then on they will have to go to large-scale installations, in which case I think we will need the assistance of industry. I think for the present this amount is apparently satisfactory.

Mr. SISK. You do not feel that the program carried on, say, for the next 10 years should be any less. You feel, as you foresee possible research now, it would require that much?

Mr. POWELL. Ten years?

Mr. SISK. It could be done for less, say, than what is proposed in the bill?

Mr. POWELL. May I make this general statement? In carrying out any research program you get the benefit of what you spend. So that if it is curtailed, I do not think it will be a loss. But to carry it out with speed, which I think is necessary, and to get it in practical operation, I think you are talking of a research period and a development period of 10 years.

Mr. SISK. The reason I ask that is with reference to something you may have heard with reference to what the Budget Bureau's recommendation might be for the amount of money. Could you tell me this, Mr. Powell? In round figures, what has been spent on this particular research program in the past years? Do you have any idea in round figures about how much money has been spent?

Mr. POWELL. I think there were $400,000 to be expended. I think it has been up to about that level. But Mr. Jenkins is here and can answer that much more accurately than I can.

Mr. SISK. That is all, Mr. Chairman.

Mr. ASPINALL. My colleague from Colorado, Mr. Chenoweth. Do you have any questions?

Mr. CHENOWETH. Just one question, Mr. Powell. How far are we away from the time when there can be some commercial value to this program?

Mr. POWELL. As a matter of fact, these desalting processes are now carried on commercially. It is not a question, can you do it; it is a question of how much it costs.

Mr. CHENOWETH. Tell us something of the commercial situation now.

Mr. POWELL. There was a plant just put in at the Pacific Gas & Electric Co., north of San Francisco Bay, in which a large evaporating installation was put in to make fresh water for their boilers.

In the Far East—and we have done some work in the Far East in my private practice—there are large installations of evaporators.

On the membranes which you spoke of a minute ago, Mr. Rhodes, those have not been developed into any large-scale plants yet.

Mr. CHENOWETH. Is the cost still so high the process is not practicable for commercial use?

Mr. POWELL. For that particular one. Evaporation of water is high anyway. That is the reason I feel very firmly that we are making an error in evaluating what it costs to get saline water. In most of these processes they develop distilled water. You do not develop distilled water for all these processes. So if you could take saline water of, say, 4,000 parts per million and dilute it down with fresh water, then you are getting twice as much water for the same price and the cost goes in half.

I think one of the errors made by the public generally when they are talking of figures is they have not evaluated saline water for its particular uses. The cost should be evaluated on the needs of the quality of the water for a particular process, and when you take that into account, then the cost, although it is high on the surface—you may be able, and quite conceivably so, to produce water, and usable water, at a much lower cost than the process on the surface shows the cost.

Am I making myself clear?

Mr. CHENOWETH. Yes. Thank you very much.

Mr. ASPINALL. The Chair recognizes the gentleman from Michigan.

Mr. DIGGS. No questions.

Mr. ASPINALL. The gentleman from California, Mr. Utt.

Mr. UTT. I just wanted to ask you, is this the only department of Government carrying on research and development or are there other departments of Government that are carrying on research and development?

Mr. POWELL. I am not quite sure. I think there are certain types of water frequently being studied by different departments. The Atomic Energy Commission is doing a great deal of work. Whether they are doing anything on demineralization and use of saline waters I do not know, but there is a great deal of research work going on in different departments.

Mr. UTT. You do not know whether the Defense Department has a full program on it?

Mr. POWELL. I know the Defense Department is doing a great deal of work along these lines, but whether or not they are doing anything on saline water directly, I do not know. I think they have it in the program, but I am not familiar with it.

Mr. UTT. Is the membrane process the one with the revolving disks?

Mr. POWELL. No.

Mr. UTT. What is the name of that?

Mr. POWELL. That is the Badger process.

Mr. UTT. Do you know whether the Department of Defense is developing that?

Mr. POWELL. I do not know. Mr. Jenkins can probably tell you.

Mr. ASPINALL. The Chair recognizes our chairman, Mr. Engle.

The CHAIRMAN. Mr. Powell, how close are we to getting this desalting process in shape where it will be useful for industrial water?

Mr. POWELL. It is now being used for industrial water. It again comes back to cost. There are many, many plants, industries, in the United States today that are desalting water by evaporation. One I just mentioned is the Pacific Gas & Electric. They are taking sea water and getting fresh water directly from sea water from these large evaporators. There are many installations of this kind. That is expensive water.

The hope in the development of this particular program is to select processes that can be developed industrially and bring the cost down, and especially in many places where they do not have cheap fuel.

The CHAIRMAN. I can see how it would be a long time before we could hope to get water by any of these processes that would be economically useful to irrigation, that is, in the normal sense throughout the West. Our water out there will run anywhere from $3.50 an acre-foot, as it is on the Friant-Kern Canal, to, say, $25 an acre-foot, as it is over on a project we have in Santa Barbara County.

I understand that water in Los Angeles may run in the order of $40 an acre-foot.

Mr. POWELL. That is right.

The CHAIRMAN. If we could get sea water down to $50 or $60 an acre-foot, we would be getting into the range where it might be, you could say, competitive with bringing in of water from other sources.

How close are we to that?

Mr. POWELL. It is my personal opinion—and this is not a committee opinion, it is an opinion which I am giving based on experience—I think the time is approaching. I would not like to be held to a timetable, but I think the time is approaching and we will actually be getting fresh water from sea water, but to do so I think it will have to be a multipurpose project.

The CHAIRMAN. By "multipurpose" what do you mean?

Mr. POWELL. I am thinking largely of using waste fuels. We have an enormous amount of heat in industry which is going to waste, and that could be turned into useful purposes for desalting water. It is something that I think is coming. This program, I hope, will take that into account before it goes too far.

The CHAIRMAN. Are we in the position yet to set up a demonstration plant for the purpose of testing the economics of any of these processes on a large scale?

Mr. POWELL. You are very close to it on some of them; yes.

The CHAIRMAN. I would like to establish a plant down in Los Angeles and test a process down there. Is there some process that you can think of that could be set up down there for a demonstration plant?

Mr. POWELL. I think that there are some that have great possibilities; whether you want to use one or another, I do not know. But what I have in mind now is an evaporator. I have talked to other people in California in the large utility field and they have exactly the same thought you have—that they would like to see one put in there and demonstrated in a plant to work out the economics of specific processes.

The CHAIRMAN. How much would that cost? Could we do it for 5 or 6 million dollars?

Mr. POWELL That depends on the size of the plant again I think you would not go to full size plant first, you would go to pilot plant. I can conceive you could put in a pilot plant on some of these processes and spend maybe a quarter of a million dollars and get design data from which you could then proceed to build a large plant.

The CHAIRMAN. Is this bill sufficiently broad to permit the establishment of that kind of pilot plant?

Mr. POWELL. I think so.

The CHAIRMAN. And could some of the money in this bill be used for that purpose?

Mr. POWELL. I think it could.

The CHAIRMAN. Well, I am stronger for this bill than I thought I was.

Mr. ASPINALL. The Chair recognizes the gentlewoman from Idaho.

Mrs. PFOST. I would like to ask Mr. Powell if study has been given to the use of atomic energy in desalting saline water.

Mr. POWELL. Yes. There has been a good deal of liaison between this committee and the Atomic Energy Commission. They are very closely in cooperation with them and have discussed this.

Mrs. PFOST. May that not be the solution to your cheap fuel?

Mr. POWELL. Whether it will in this country or not, I do not know. I am definite it will be in some of the arid regions of the world.

The CHAIRMAN. One more question. Do you think it would be inappropriate for us to put a special direction in this bill that a portion of this money be used for the establishment of a pilot plant?

Mr. POWELL. If it is not in there specifically—I thought it was, but if it is not named specifically, I think it is the intent.

Mr. ASPINALL. Are there any further questions?

If not, the Chair wishes to compliment the gentleman on his fine statement.

Mr. POWELL. Thank you, sir.

Mr. ASPINALL. We are very pleased to have had you with us.

Mr. POWELL. Thank you.

Mr. ASPINALL. This will conclude our meeting this morning. We shall meet again at 10 o'clock tomorrow morning for further consideration of this bill.

(Whereupon, at 11:55 a. m., the subcommittee recessed to reconvene at 10 a. m., Thursday, February 17, 1955.)

RESEARCH IN THE DEVELOPMENT AND UTILIZATION OF SALINE WATERS

THURSDAY, FEBRUARY 17, 1955

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION
OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 11 a. m., in the committee room, New House Office Building, Hon. Wayne N. Aspinall (chairman) presiding.

Mr. ASPINALL. The Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs will now be in order for further consideration of H. R. 2104 and H. R. 2126, identical bills.

The Chair has in his hands a favorable report from the Department of the Interior under date of February 16, 1955, and unless there is objection, it shall be placed in the record of the hearings at the beginning of today's session.

Hearing no objection, it is so ordered.

(The report referred to follows:)

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., February 16, 1955.

Hon. CLAIR ENGLE,
Chairman, Committee on Interior and Insular Affairs,
House of Representatives, Washington, D. C.

MY DEAR MR. ENGLE: You have requested a report on H. R. 2126 a bill "To amend the act of July 3, 1952, relating to research in the development and utilization of saline waters."

The act of July 3, 1952 (66 Stat. 328, 42 U. S. C., 1952 ed., secs. 1951 ff.) authorized the appropriation of a total of $2 million to enable this Department to carry on, through contracts with private scientists and engineers, educational institutions, scientific organizations, and engineering firms, a 5-year research program looking to "the development of practicable low-cost means of producing from sea water, or from other saline waters, water of a quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses * * *."

Enactment of H. R. 2126 would modify the basic act by extending the period under which operations can be conducted under it, by increasing the amount authorized to be appropriated for the conduct of these operations, and by permitting research to be carried on to a limited extent in existing Government laboratories.

It is the recommendation of this Department that H. R. 2126 be enacted.

Continued expansion of our industries, our growing populations, and expanding agricultural production have increased tremendously the demand for large quantities of fresh water. This continued growth and expansion has placed a severe drain on our water resources in certain areas. In many instances, new reservoirs have had to be constructed and water transported over great distances, in other cases the water supply has been supplemented by new wells which have lowered the water table. The pumping of ground water for irrigation in many areas has been at rates considerably above the safe yields as estimated by the United States Geological Survey. The sources of water on which we normally rely are gradually

being exhausted and, through use and reuse, the supplies derived from these sources are being contaminated. The need for finding additional fresh water sources therefore is obvious.

Results during the past year have demonstrated the need for, the usefulness of, a Government program of this nature. Most industrial firms do not feel justified in carrying on the development of saline water conversion equipment beyond certain improvements in present equipment. To accomplish the demineralization of large quantities of saline water at a fraction of the present cost will, however, require much more development of new principles and processes than improvements in present processes. The Government program assures that research and development investigations will continue both on the development of new and untried methods and on improvements in present methods.

At the beginning of the program, the cost of converting sea water to fresh water by the best processes in use was estimated at about $400 to $500 an acre-foot. Accordingly two cost goals were set for the initial 5-year phase of the program, one for water for municipal and similar purposes and one for irrigation water. (For these criteria, no distinction is made as to whether the water to be converted is sea or brackish water.) These goals were $125 and $40 per acre-foot (38 and 12 cents per 1,000 gallons), respectively, and they were believed, on the basis of data then available, to represent about the maximum that could be borne by these types of use. Although considerable work remains to be done before those initial goals are fully realized, they are being appoached and it is believed they can be reached and lowered if the research is continued. In other words, the results to date indicate that the conversion of sea water to fresh water at a price which minicipal users and some industries might pay and the conversion of saline water to irrigation uses may be in sight.

Recent results have indicated that no single process will provide fresh water for all purposes at all locations and under all circumstances. Thus it is desirable that several different principles, processes, and combinations of processes be investigated and developed concurrently. In addition, it is becoming increasingly apparent that nonconventional low-cost energy (e. g., solar, wind, geothermal energy, etc.) must be investigated in connection with process development and use.

Preliminary results obtained from one vapor compression investigation and extrapolated to large-scale operation indicate a good possibility of producing fresh water from sea water for approximately one-fourth the cost of distilling water by any process in use at present.

Preliminary estimates for a critical pressure device of large capacity likewise indicate that fresh water may be obtained from sea water at costs much below those of existing processes if 2 or 3 critical problems now under research study can be solved.

Other processes under development include an ion transfer membrane demineralizer which is undergoing field test at the present time; various aspects of the vapor compression distillation process, some of which will reach field-testing stage next year; solar distillation, solvent extraction, freezing, osmotic processes and ultrasonics.

Initially, most of the research and development on processes has been on a relatively small-scale laboratory basis and only nominal expenditures have been required. Much of this exploratory and more or less fundamental research needs to be continued. However, as individual processes which show sufficient promise are developed in the laboratory, pilot plants or field tests become necessary. Such tests are essential in order to obtain reliable cost estimates and information on the durability of the unit, down time, production capacity, power requirements, corrosion, etc. Developmental work, including field tests of this type, is more costly than laboratory investigations.

Under the provisions of the Saline Water Act of 1952, all work undertaken pursuant to that act must be completed prior to July 15, 1957, the anniversary of the date of the first appropriation to implement it. Not only all research activities and field tests under contract but also all reports thereon and the correlation and coordination of all data must be completed by that date.

Since most research and development contracts are for a period of about a year, it would thus be necessary to terminate most active research contracting by about December 1955 to permit completion of the work under the contract and final reporting of the results and conclusions of the program by July 1957. Only a small portion of the appropriations for fiscal year 1957 could be utilized for contract research just at the time when the need for advanced research and development of promising processes is expected to be paramount.

To permit continuity and the attainment of the program's goals, an extension of time is desirable. The results obtained to date are, as has already been noted,

sufficiently encouraging to indicate that, if the activity is given sufficient time, economical processes for the treatment of brackish water and sea water will be developed. Research of this type is perforce long-range in character. Unless assurance can be given to the private firms and research organizations who are serving or will serve the program as contractors that promising studies will be carried to completion, we will have difficulty achieving worthwhile results even in fiscal years 1956 and 1957. Assurance that the program will not be interrupted is needed now if we are to undertake research that will not be completed until after fiscal year 1957. Interruption or abandonment of the program after fiscal year 1957 would, in any event, dissipate a large part of the valuable results already achieved or anticipated, with a consequent loss to the Government.

Since the initiation of the research program under the act of July 3, 1952, excellent cooperation has been received from various organizations. Efforts are continually being made to encourage private development of processes and to interest industrial firms in the problem. The expansion of our basic authorization proposed in H. R. 2126 to permit an expenditure up to $500,000 for research to be conducted in existing Government laboratories would, however, prove advantageous in a number of ways. Several indivdual scientists have had ideas on processes worthy of at least exploratory research effort but do not have laboratory facilities available. Some would be agreeable to having the research carried out at a Government laboratory but the research has not been carried out because of apparent lack of authority to utilize such laboratories. Government scientists, in some cases, have worthwhile research to propose in which they and their laboratory are best qualified to proceed. Another area in which operations in a Government laboratory would be valuable is in making unbiased comparisons of processes and in confirmation of research results. In some cases, Federal scientific organizations offer the only satisfactory personnel and facilities to conduct certain investigations.

The Bureau of the Budget has advised that there would be no objection to the submission of this report to your committee but that no commitment can be made at this time with respect to the amount of $6 million which the bill, if enacted, would authorize to be appropriated.

Sincerely yours,

FRED G. AANDAHL,
Assistant Secretary of the Interior.

Mr. ASPINALL. Our colleague, Congressman Wilson of California, has a statement which he wishes to present to the committee at this time. We welcome you this morning, and we will be glad to listen to your presentation.

STATEMENT OF HON. ROBERT WILSON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. WILSON. Thank you, Mr. Chairman, and members of the committee. I appreciate your giving me just a few moments here to discuss H. R. 2126.

I am from San Diego, Calif., and am very much interested, and our county of San Diego is very much interested, in the sea water conversion program of the Department of the Interior.

I am sure the chamber of commerce out there would not object to my making the statement that we would be a complete desert even now if we did not have water brought in to us from outside our own territory.

We have had an amazing population growth in the past 50 years in California. In our southern California area, alone, we have over 7½ million people. Of course, that means a tremendous use of water. We are always looking ahead to our water needs. We brought in water from the Colorado some thousands of miles, and now we are even looking up into Chairman Engle's territory for possible water sources up there, some means of perhaps pumping it over the range

of mountains and bringing some of his fresh mountain water down from the Trinity River area.

The CHAIRMAN. Will the gentleman yield there?

Mr. WILSON. Yes.

The CHAIRMAN. It is true, is it not, that southern California has water filings in my district north of a line parallel with San Francisco?

Mr. WILSON. You would be the expert on that point, Mr. Engle. I cannot verify that. If you say so, it is true in my book.

The CHAIRMAN. I thank the gentleman.

Mr. WILSON. Seriously, if we look at our population growth, we will find it is right on the ocean. Los Angeles and San Diego, the two major cities in southern California, are right within miles of the Pacific Ocean, and we believe that sea-water conversion holds our greatest promise for our continued population growth.

I was fortunate last summer in going up to Boston, together with Mr. Rogers and some other members of the committee and some of the Senators, to look into two processes that have been included in the Department of the Interior's program. I was particularly impressed with the Hickman still that the Badger Manufacturing Co. is now currently working on. I understand that Dr. Hickman is going to give some testimony here in a few minutes on that subject.

It seems to me that this process holds an exciting promise for a low-cost means of getting water from the ocean. While it probably has yet to be proved, I am hopeful that this committee can extend the authorization of the Interior Department to continue to experiment along such lines and eventually can include the construction of a pilot plant, so that we can test these laboratory theories that seem to be proving out.

I believe the Interior Department has very wisely looked into every possible means of sea-water conversion rather than concentrating on 1 or 2 processes, and then are taking those with the greatest promise and are going to take the next step, which will be a pilot plant to actually test the laboratory tests and to prove out whether it is feasible economically.

It seems to me that in our area we have to look to converted sea water for our domestic use of water. I doubt, frankly, if we can ever get the cost of sea water converted into fresh water down enough to be satisfactory, to be low enough for agricultural use. But certainly, from a domestic use in these great population areas, sea water holds our greatest promise for the future.

I hope you will favorably consider H. R. 2126 and that you will authorize the construction of some pilot plants, once you are sure and the Interior Department is sure they have some methods that hold reasonable promise and expectation of success.

Thank you very much, Mr. Chairman.

Mr. ASPINALL. Thank you, Congressman Wilson.

Mr. SAYLOR. I should like to ask the distinguished gentleman from California a question or two.

Mr. Wilson, you have said that your State has had in the southern end this phenomenal growth of which we all have been apprised by the very able representation that your State has here in the House and the Senate. But you know and I know that regardless of whether you have 1 person there or 7½ million people there, they cannot live without water.

Mr. WILSON. That is right.

Mr. SAYLOR. You have also made the statement that you hope that this committee would see fit to pursue or further assist the Bureau in pursuing research to the end that saline water or brackish water, or whatever is available, might be made usable both for civilian, municipal use, and for probable industrial and agricultural use.

Now in view of the fact that you have 7½ million people in southern California and it is necessary for them all to have water to sustain life, what criteria should this committee use for feasibility? What criteria should the Bureau use for feasibility in view of the fact that the water is a "must" to live?

Mr. WILSON. I think probably the main criteria will be economic, the ultimate cost of the water that will be delivered to the consumer. Yet I do not feel that within the scope of the experiments to date we have been able to get reasonable estimates even on what the cost might be of the processes under consideration. Therefore, we need to continue to invest a small amount of money such as has been invested on determining what the economic justification of sea-water conversion will be.

Mr. SAYLOR. If it is absolutely necessary to maintain life and the people in southern California are going to grow as they have in the past 15 years, then what difference does it make what the cost is?

Mr. WILSON. It is comparative costs actually of one method of getting water over another. That is going to be the ultimate decision we must make, I am sure.

Mr. SAYLOR. Suppose the Bureau comes up with a proposition that it will cost $200 an acre-foot for water. Would not the people in southern California be willing to pay $200 an acre-foot for water if it was necessary to maintain life and grow, even though it might be a hundred times more than they are paying for water right now?

Mr. WILSON. I am not prepared to say we would be willing to pay any specific amount for water. Certainly we will pay what we have to pay when the time arrives that we need it. I am confident that we are interested in finding the lowest cost water we can get.

The CHAIRMAN. Will the gentleman yield to me there?

Mr. SAYLOR. Yes.

The CHAIRMAN. The precedent on that point, which I think will be of interest, is that in Colorado Springs where the Air Force has audaciously established an Air Academy, that city has recently offered to pay $350 an acre-foot to get some water and they were turned down. It was not enough. But they are willing to pay it just the same. I do not know what it is going to cost, of course, to get the needed water for the Air Academy out there. I have been trying to find that out.

Mr. ASPINALL. Might the Chair say that we have four witnesses and it will be necessary to take the time for consideration of their statements this morning so they will not have to be called back here again. I appreciate the contributions of the gentlemen from Pennsylvania and California, but we are rushed a little bit.

The CHAIRMAN. We did not want to argue that point, Mr. Chairman. I just wanted the record to show what one city, dry as bones, is willing to pay for the water.

Mr. CHENOWETH. I want to assure the chairman of this committee that Colorado Springs has plenty of water to take care of the Air

Academy. The water supply has been checked carefully time and time again, and I want to relieve his mind of any apprehension that he may now have concerning the matter.

Mr. ASPINALL. Would my colleague be kind enough to wait until a further moment?

Mr. CHENOWETH. Yes; but I could not let the statement of our chairman go unchallenged.

Mr. ASPINALL. Thank you very much, Mr. Wilson?

Mr. WILSON. Thank you, Mr. Chairman.

Mr. ASPINALL. For the benefit of the committee and the Department, this Subcommittee on Irrigation and Reclamation will hold another meeting on Thursday, the 24th of February, for what the chairman hopes will be the final consideration of the legislation now before us. At that time we shall have the representatives of the Bureau before us before we proceed to amending the bill, if there are any amendments.

At this time the Chair recognizes Mr. Jenkins, with the understanding that we have not longer than an hour, Mr. Jenkins, to make the presentation.

STATEMENT OF DAVID S. JENKINS, DIRECTOR, SALINE WATER CONVERSION PROGRAM, DEPARTMENT OF THE INTERIOR—Resumed

Mr. JENKINS. Thank you, Mr. Chairman.

I will take just a moment, if I may, to say that under the provisions, which I consider to be so fine, which this committee initiated, of having this work handled by scientists in private life, largely, it has been possible to obtain the assistance and help of some of the best thinking people, the best scientists, in the country.

We have today asked four of the people who are working on this problem to meet with us, and they are all from the nearby northeastern part of the United States. That does not mean that we do not have work in other places. These people are from New York and New England, but we have work in Ohio, in Michigan, in South Dakota, in Florida, in Texas, in California, and in the State of Washington. We did not want to ask all of them to come in at considerable expense, but in 1 or 2 cases the people who are here will do their best to speak for those who are not here.

With that short introduction, I should like to ask the gentleman who is one of the several actual scientists working on the process known as critical pressure distillation, which I mentioned yesterday as having been suggested earlier by a Swedish scientist, to present his statement. That work is undertaken under contract with the Nuclear Development Associates of White Plains, N. Y. That organization is a young one. It has some 75 senior scientists similar to the one who will be heard from today, and they have many different problems related to activities other than nuclear developments.

With that, I should like to introduce Dr. G. L. Laserson, who was born in Vienna, Austria, was educated in Columbia University, has a doctor of philosophy in mechanical engineering. His experience has been with DuPont for 5 years and with the Nuclear Development Associates since 1953. His present position is section head at Nuclear

Development Associates, and he has a number of important scientific publications.

Dr. Laserson.

Mr. ASPINALL. We are glad to have you with us, Dr. Laserson.

STATEMENT OF DR. G. L. LASERSON, NUCLEAR DEVELOPMENT ASSOCIATES, INC.

Dr. LASERSON. Mr. Chairman, ladies and gentlemen of the committee:

It is quote an honor for me to appear here and I hope my short presentation will be of some value.

Our company has been working in the field of water purification and research actively for somewhat over a year. We have been doing some survey work on it earlier than that and got quite interested in the critical distillation process invented by Von Platen in Sweden. Then we started to develop and do some research work to determine its actual applicability in large-scale water conversion.

I would like to briefly outline the process on this first slide.

This is a rather crude diagram. Sea water is taken in here [indicating] and pumped up to a high pressure force of 5,000 pounds, passed through the heat exchanger and the separator. In the heat exchanger it picks up most of the heat necessary for the separation and some small additional heat is imposed in the separator. In the separator the water is divided into 2 streams, 1 fresh water and 1 concentrated brine, which is then passed back through the heat exchanger and gives up there heat to the incoming sea water, still at high pressure.

The 2 streams then pass through the 2 turbines where the pressure energy is recovered and used to partially drive the pump. Some additional energy for the pump is, of course, required.

This briefly describes the process as invented by Von Platen.

Mr. ASPINALL. Doctor, do you have a copy of the chart which you have there?

Dr. LASERSON. It is included in the third annual report of the Secretary.

Mr. ASPINALL. Which you are furnishing the committee?

Dr. LASERSON. Yes.

The first thing that we did was to make a brief economic study as to the potentiality of this process. It looked very promising on a purely theoretical basis.

On the basis of available experimental data, which were fairly meager, and present power costs we calculated what it would cost to design, build, install and operate a large-scale plant, and found that if everything worked out all right water costs could be brought down to somewhere in the order of $100 per acre-foot. Consequently, it looked rather promising compared to other methods, and it was decided to proceed and do further experimental work.

Several serious problems exist as to the fasibility of the process. It is, first of all, necessary to demonstrate how the salts are separated from the water and at what temperatures and pressures this occurs in an optimum fashion.

We have done considerable research on that, and I believe we have covered the field pretty well. We now know fairly well as to the way we want to operate.

This alone is not enough, however. The next question is, can we build such a plant with other materials that can withstand the extreme requirements of the temperature, pressure and corrosion which exists in such a plant. We have conducted research on corrosion and resistance of special materials, metals such as titanium and others, which may be promising in its application. For the moment titanium looks very promising. Further work has to be conducted, however. Corrosion research is a long-term process essentially. You have to wait a long time before anything happens. So this work is still in process.

The third very serious problem is that of scaling and sludging. Naturally, when you try to evaporate water by any process whatsoever, whether high pressure or low pressure, whether high temperature or low temperature, the salts will tend to deposit out on the walls of the equipment. That should be avoided. It has to be avoided to some extent or the means have to be provided for the surfaces to be cleaned, since the equipment otherwise becomes inoperative. In this particular case scaling and sludging is particularly serious because we do operate at very high temperatures, up to around 800° F. The problem thus becomes serious. Furthermore, no past experimental laboratory or plant experience exists under these conditions. So essentially we have to start from scratch and build up that experience.

Now all this work—and there is a lot of it and it is critical—will determine the feasibility of building such as plant.

If I may revert to what I said earlier, the only justification for doing this extensive amount of research work is that the promise of the method is high. The potential is very favorable. Once that has been decided, I think technical work is justified in attempting to reach that potential promise.

The way we are trying to conduct the research is in a step-by-step fashion, one problem at a time. Let us first find out whether one critical problem can be solved. If that is so, let us proceed to the next critical problem. If we reach one stumbling block we cannot overcome, there is no point in spending any further money on this system. So we have been taking one step at a time, and as it stands right now we are concentrating on the problem of scaling, sludging, and corrosion, the problems that govern the construction of the plant.

We also will have to do some experimental work in determining thermodynamic properties of sea water, on which no data exists at present. That work will be undertaken shortly. Once this laboratory work has been completed, and let us assume successfully, for the moment, then the next step is to build a large-scale test facility, experimental research facility, pilot plant, if you wish, in which we can produce water continuously.

Mr. ASPINALL. Would you mind advising this committee the difference between a pilot plant and a demonstration plant right at this place in the record?

Dr. LASERSON. Certainly. A demonstration plant, in my mind, is something that is built when we know all about it and all we have to do is show how it works. A pilot plant, to my mind, is a research facility, a plant in which we do experimentation. We have arrived at design criteria, we think we can now build a plant, but there are always problems that can be licked until you have built small plants. Furthermore, you have to have research facilities on which you can get economic and operating experience, and actually evaluate cost on

practical operation, determine what maintenance problems you run into, what control problems you run into, what kind of training your operator needs. So that, I would say, is a pilot plant. This is a research facility. It is bigger than a laboratory, but it is still a research facility. But in a demonstration plant all you want to do is show how a process works to somebody who is not familiar with it. A rather different aim, I would say.

I think the pilot plant is the one we shall need. We have made some preliminary studies as to what such a pilot plant might consist of, and we have picked an arbitrary figure of a small-scale plant that might produce some 5,000 gallons per day, and it might cost somewhere in the neighborhood of a quarter of a million dollars. This is a rough estimate right now, just to give an order of magnitude idea.

Why does such a plant cost so much money? High-pressure equipment is expensive. The reason why we think the process is economically promising is because, although we use high-pressure equipment, we can cut down on energy requirements.

Just as an illustration, I would like to show you another slide of some of our experimental equipment in the laboratory. That is a view down into a circulating loop into which we pump some of this sea water at pressure up to 5,000 pounds and temperatures of 900°.

To give an idea of the scale of the equipment, it is a cubical, approximately 6 feet on the side. It is small equipment. We can learn a lot from such equipment, but we cannot get operating data and we cannot discover the problems that we will run into when a plant has to be built.

So that is going to be a necessity, provided we can solve the problems that we run into with this. Always "provided." We hope we can. Since we are doing research, we cannot guarantee it.

I think this approximately covers what I wanted to say, and I want also in conclusion to thank Mr. Jenkins and his staff for their very valuable cooperation and guidance in doing this research.

Mr. ASPINALL. Thank you very much, Doctor. If you will take a seat back there until we hear from the others, then we will have you back.

Dr. LASERSON. Thank you.

Mr. ASPINALL. Mr. Jenkins.

Mr. JENKINS. We have been hearing of the Hickman process, Mr. Chairman. Dr. Kenneth C. D. Hickman was born in London. He taught at the Royal College of Science in England. He came to this country about 1924 or 1925, where he was associated with the Eastman Kodak Co. in charge of much of their research. He is credited with discovering molecular distillation of vitamins, and we all know what that means. He was vice president of the Distillation Products Co., a subsidiary of Eastman Kodak, from 1939 to 1948, and in about 1951 he got the idea from his previous work of this high turbulence compression still. He was backed by a local financier, Mr. Dickinson, and after some work, we were approached in the Department for assistance.

The idea was taken to the Badger Manufacturing Co. of Boston, with whom Dr. Hickman is now associated and with whom the Department has a contract for the development of his process.

May I present Dr. Kenneth C. D. Hickman.

Mr. ASPINALL. Dr. Hickman, we are very glad to have you with us this morning.

STATEMENT OF DR. KENNETH C. D. HICKMAN, BADGER MANUFACTURING CO., BOSTON, MASS.

Dr. HICKMAN. Thank you, Mr. President. It is a great pleasure and privilege to present the material to this committee.

I am going to take the liberty of opening the subject in rather broad terms.

The separation of water from salt is something that occurs which scientists call interface, and the greatest interface in nature is the surface of the sea. The composite interface is the surface of the sea and the air above it and the clouds, and the steam goes up from the sea into the clouds and then comes down as rain. You have an enormous area exposed over the whole world.

The efficiency of that natural interface is, according to the temperatures, somewhere between 1 part in 10,000, 1 part in 100,000. If we could remove the air and scientists could get into the surface of the earth, they could make that interchange of rain occur somewhere between 10,000 and 100,000 times faster.

Now the great natural problem then is, How do you draw water and salt apart at an interface? What is the smallest interface you can operate with?

It is a problem. It is a traffic problem. You have got to get the water molecules to go one way and the salt molecules to go the other way, and if you hurry them or squash them too much, they just get bunged up at the interface and will not move.

You see how tremendously important that problem is when you think of the human being. One great function of the body is to separate salt from water, and that is what the kidneys do, and that is the part of the body which wears out first. So in old age you go on a salt-free diet because you cannot separate the salt from the water.

What we are trying to do is produce a kind of mechanical kidney that will give the world the water it needs. There are all kinds of ways we can do this. There are 101 methods, all of them drawing salt and water apart.

Protagonists of the electrical and membrane method say, "We have a little salt to get out of a lot of water. So we will go in and pull it out by electricity or membrane or powder or something." The protagonists of the opposite method say, "No, we will not do that. We will draw the water off the salt."

Now one of the ways of drawing the water off the salt is to try and push the water through an osmotic membrane. Again this traffic problem, because as you push, you push the salt molecules into the membrane and they bunge it up, just like traffic gets stalled when it gets heavy at the rush hour.

Another way is distillation. Now, unfortunately, distillation uses a great deal of heat. For every pound of water that is distilled, a thousand units of heat have to be expended.

I would like to come to the blackboard now, if I might, and get my chart here. I must remind you that the question of how to distill water has been known for a good many thousand years, and this is an improved kind of tube boiler which has been used, perhaps, for the last 100 years.

This pink is the fire underneath the boiler. The green is the water in the boiler. The white is the boiler tubes here. The yellow is the steam and the blue is the distilled water.

The fire goes round the boiler tubes and comes out the chimney. The steam comes off the top and we take it away to the separate condenser.

We are going to need a thousand units—I will not bother to name the units—a thousand units for each pound of water.

Now shortly after Watt invested the steam engine, an Englishman in 1856 got the idea of what is known today as the compression still. It is interesting that the compression still never came into use until 1934, but it was invented in 1856. He got the idea of taking this conventional boiler and taking the steam off the top and feeding the steam back into the boiler, right into the fire box, instead of the coal fire; and he just had to raise the temperature and the pressure of the steam enough so that the steam condensing would pay back this thousand units of heat. He did that by raising the pressure sufficiently so that he had to use about 60 units of heat in this engine here to pay back the heat that was being expended.

Now the well-known Kleinschmidt still, which I believe was made by the predecessor of the Badger Co., was used, of course, extensively in the war for this kind of purpose, and it was able to meet wartime needs. Now for peacetime needs we have got to go down to a completely new order of treatment.

Where do I come in? I come in simply because I have a hunch that I know how to do the distillation thing. I am not saying the distillation of it is better than any of the other methods that could be produced now or in the future, or that are going to be demonstrated today before this committee. I merely say, if we are going to do it by distillation, I think I know how to do it because I think I know what the problem is.

Let us look at this engine here. We have got to take the steam around and push it around these tubes. It has got to get into the water. The water has to raise bubbles which are going to form there to form steam. They are going to push their way on the surface and get up into the pump. This pump has to be what is known as a positive displacement pump.

It seems to me, if we could simplify this so that the steam could get out easier, we might be able to use just a simple fan, a drugstore fan, if you like, to blow the steam from one side to the other.

In 1951 I tried the experiment using a tea tray and a vacuum cleaner motor. I won't tell you it was a gross failure, but it suggested it could be done.

The system is very simple. You pour salt water on one side of the tea tray, let it drip off, take the steam and blow it around the edge and blow it on the back side.

If my drawing is not very convincing, you can see here the white is the tea tray and the green is the sea water poured on one side, and these whirlagigs are the fan blowing the stuff around to the other side.

At this time my good friend Mr. Dickinson came forward and said, "The only trouble is you did not spend enough money on it. Let us try it again." And we tried it again with properly engineered machinery and were surprised to find—now I have got to be a little technical. In the best steam practice today the number of these units that can get through for a rise of 1 degree Fahrenheit on a square foot in an hour is in the order of about 600. That is what, for instance, Detroit Edison got in their big powerhouse in Detroit. They are

using a merit figure of 600. The well-known Badger Kleinschmidt still has a merit figure of somewhere between six and eight hundred. So the first measurements we did on that gave us a figure of 1,250. At the end of a week we had 1,900; by the time our third model was built, 3,500; and this last week we have realized experimentally for a few minutes only figures up to six and seven thousand.

Now let us take the magic figure of 6,250. What does that mean? That means on one square foot we can make 6¼ pounds of water for 1 degree Fahrenheit, and for 10 degrees Fahrenheit we can make 62.5 pounds of water.

Now what is 62.5 pounds of water? A cubic foot. So we can make a cubic foot on a foot area in 1 hour.

Now a depth of 2 feet in synthetic rain would service the Washington area here because, when rain comes down here, it comes down too much at one time and not enough at another time. But if we can make it regular we can get by with a half or a third of the rainfall.

So we can make in 2 hours on an acre as much as would fall on that acre in a year in the ordinary way.

What about power costs?

We have got this figure already, from 60, the Kleinschmidt still, down to about 15. It takes about 15 B. t. u.'s on this tea tray to push it around from one side to the other.

Where are we practically?

I do not know what the definition, the difference is between a pilot plant and—all I can say is we have made 2 or 3 stills, and on an area of less than the light up there [indicating] we can make the order of three to four hundred gallons a day with the same amount of power that is going into that electric bulb.

I noticed that you were saying a little while ago, or somebody said, what is the criteria of what you can afford.

Supposing we were talking about manufacturing ice in comparison with what it can be got for at the North Pole, it is impossible to do. Yet everybody has an icebox in their kitchen where they pay immeasurably larger amounts for just a few cubes because it is convenient.

We have made our first machine. We have got to the place where we think we know how to make a machine sufficiently cheaply so anybody who wants to live where there is sea water can get water to live there.

The next stage of the process is to get to a reduction to practice on a municipal size. I think that if you gentlemen will support the bill to provide funds for this kind of an experimentation that we can get a reduction to practice very quickly.

I want to state what I mean by a reduction to practice. The motorcar was reduced to practice in 1900, but it is still being improved today. I think the task ahead of this committee is a 10-, 15-, or 20-year task, but I think that we can get an immediate reduction to practice, and I think that every dollar that you funnel into work of this kind will pick up 1, 2, 3, 10, or 100 dollars from industry. You simply act as the leaders in this vitally important type of development.

Thank you, sir.

Mr. ASPINALL. Thank you very much, Doctor.

Would our colleague, former member of this committee, Mr. Crawford, care to come up and sit with us? We will be glad to have you up here.

Mr. CRAWFORD. Thank you, Mr. Chairman. It is a very interesting subject.

Mr. JENKINS. Mr. Chairman, early in the program a number of exploratory research contracts were let in which we simply asked a man to sit down and think about this subject, use whatever laboratory equipment he had, and we did not specify very closely what he should do. I believe we were criticized a little for that, but we felt that that approach in a few cases would produce good results if placed with competent scientific people.

One such contract was placed with the New York State University under Dr. George W. Murphy. He was required to work out the heat and energy requirement for all these processes. In addition, he was required to pick up anything new that he could.

He has followed the membrane process very closely, as well as the thermodynamic processes, and has made a study, both in Europe and in this country, of the membrane processes.

Rather than bringing some of our industrial people in from the membrane work we thought that Dr. Murphy could very briefly mention this subject as well as the thermodynamic processes.

This will take about 5 minutes, I believe, Mr. Chairman.

Now, Dr. Murphy is from the State University of New York. He is chairman of the department of chemistry there. He has a doctor of philosophy degree from North Carolina in 1946. He was with the University of Wisconsin from 1946 to 1951, and with the Argonne National Laboratory of the Atomic Energy Commission from 1951 to 1953.

Dr. Murphy.

Mr. ASPINALL. Dr. Murphy, we are very glad to have you with us, several members of the committee have visited the operations in Boston and seen this procedure in action.

STATEMENT OF DR. GEORGE W. MURPHY, STATE UNIVERSITY OF NEW YORK

Dr. MURPHY. Thank you, Mr. Chairman. It is, of course, a great pleasure for me to be here and talk as much as I can about these things we have been working on, the things we have been observing.

As Mr. Jenkins has indicated, my little discussion here is going to be somewhat different from those two who have gone before. I am going to speak in somewhat more general terms.

Originally I had three topics listed which Mr. Jenkins had suggested, but that has been cut down to two, and the time remaining does not give me much chance to be eloquent on any one of those.

The work that we did at the State University of New York during the fiscal year 1953–54 was of a purely theoretical nature, and I think that this was quite a far-sighted outlook on the overall saline water program by the administration of that program.

The idea was to take a good broad look at the energy requirements for methods in general, particularizing on those which were leading methods at the time, and to see what we could come up with as a sort of energy requirement for a practical process.

Now, any student of physical chemistry at college can calculate for you in a very few minutes what the so-called minimum thermodynamic requirement is for sea water demineralization. It is about

2.8 kilowatt-hours per 1,000 gallons, and at average industrial rates this would bring water, if you counted only the energy costs alone, within the reach of any municipality or for any irrigation use. But this figure, which is so easy to get, requires unlimited means, and of course unlimited means are never at hand. It is a much more difficult problem to calculate a minimum that is in practical attainment, and that is the job we set out to do.

Without going into the details of the methods of our calculations, I can say that it is based on a fairly new development in physical chemistry, which may be referred to as thermodynamics as irreversible processes, as opposed to, classical thermodynamics of equilibrium processes. On the basis of certain idealized, but somewhat practical, processes, we come out with a conclusion that a practical minimum energy requirement is about 4 times the classical minimum of 2.8 kilowatt-hours per 1,000 gallons. In other words, about 12 kilowatt-hours per 1,000 gallons.

Now energy is the real key, you see, to economical sea-water demineralization. It is not the only thing by any means. Of course your plant costs are very important, but we have taken these into account more or less in arriving at this so-called practical minimum.

This figure that we have arrived at is not what we would call a probable attainable minimum, it is a minimum which might be achieved if leading methods were developed to their absolute ultimate efficiency.

Now, because the electrical membrane process is one that has received a rather intensive report from this saline water program, I am going to say a few words about that at this time.

This is one of the methods, of course, we considered in some detail in this theoretical study. We are not working on membrane development at New York. However, we are presently working on a process which will use membranes, but it is not a conventional use. However, I have made some study of membranes, so I think I can tell you something about the process.

First of all, we have to take a look at what salt looks like what you dissolve it in water. Salt is the principal dissolved constituent of sea water, and we all know, of course, when you put the salt in water and shake it up the salt disappears. But if we could take a look with a very, very powerful supermicroscope, one, of course, which we do not have, we would see that the particles of sodium chloride break up into charged constituents, two charged constituents, which are sodium and chloride ions. The sodium ions have a positive charge and the chloride ions have a negative charge. We know this because, if we put electric poles in the solution and connect them to a battery, the sodium ion goes toward the negative pole and the chloride ion goes to the positive pole.

Now this is the basis for one method of demineralizing water, the electrical method, but it is not efficient unless you have sieves which will sort out these two ions, and the so-called perm selective membranes which are the basis of the membrane process are the sieves which sort out these ions.

One type of membrane sorts out only sodium ions and the other type of membrane sorts out only chloride ions. And when we put these membranes in a stack of alternating membranes type and form a cell, fill the cell with sea water, and connect the ions through elec-

trodes to a battery, we find alternate compartments in the cell have had their salt taken out. In contrast to the method which Dr. Hickman talked about, this is a method for removing salt from sea water instead of removing water from sea water.

Now on the basis of presently available evidence, this method has turned out to be quite effective for the demineralization of brackish water. Brackish water contains, roughly, a tenth as much salt as sea water, and the energy costs for this process for a given piece of equipment depends upon the amount of salt that is there. You can say, roughly, if it costs you so much to demineralize a sample of brackish water, it will cost roughly 10 times that much to demineralize sea water. So at the present time sea water is not in that picture, but the saline water conversion program has been pushing rather vigoously the use of this method for the demineralization of brackish water. This includes a pilot plant, and on this pilot plant, which is mounted in a trailer so it can be moved to various brackish water sites, tests are now being carried out. As far as I have been able to determine, these tests prove everything that has been predicted in the laboratory studies.

I would like to close by just saying one thing that we are doing up in New York in relation to these membranes.

We have devised a way by which we can put membrane stacks together which do not require electric energy. A new type of power source is involved there which uses essentially brine in combination with the source, saline water, to move the sample of salt out of another bit of saline water, and we think that this particular method is rather promising and should be developed further.

Thank you.

Mr. ASPINALL. Thank you very much.

Off the record.

(Discussion off the record.)

Mr. ASPINALL. Proceed, Mr. Jenkins.

Mr. JENKINS. Mr. Chairman, we usually try to ask the ladies to speak first, but in this case we thought it would work out a little better if Dr. Maria Telkes appeared last of the four.

Dr. Telkes is experienced in many physical and chemical pursuits. She has been at Massachusetts Institute of Technology and is now at New York University. She is working at New York University as the project leader on the development of solar energy stills. She is one of the three under contract for that purpose. One of the other two is in Madison, Wis., the other in Denver, Colo. In addition, work is being conducted at the University of California in cooperation with this program on solar distillation.

I have asked Dr. Telkes this morning if she will describe briefly what she is doing in this field at New York University and also cover quite briefly what the others are doing in their behalf.

Dr. Telkes was born in Hungary. She is a physical chemist. She has been interested in solar energy since high-school days. As I mentioned, she was at MIT for a number of years. She developed the life raft still and that was used during the war. She has been instrumental in building one of the first, or perhaps the first, sun-heated houses in Cambridge, Mass. She studied conversion of solar energy into electrical energy and is now at New York University in charge of solar energy projects.

Dr. Telkes.

Mr. ASPINALL. Dr. Telkes, we are very glad to have you here this morning. We have two members of our committee who are distinguished representatives of your sex. An additional welcome, therefore, goes to you.

STATEMENT OF DR. MARIA TELKES, NEW YORK UNIVERSITY

Dr. TELKES. Mr. Chairman and ladies and gentlemen, solar energy can be used to produce fresh water from sea water. As you know, nature does that on a tremendous scale when the sunshine evaporates water from any open water source, lakes or ocean, and the water is lifted as vapor, condenses into clouds, and finally falls down again as rain.

As Dr. Hickman mentioned, this process is very inefficient, and the whole solar distillation idea is, of course, centered on making the process more efficient so that by some device we can change sea water or salty water into fresh water.

We would actually obtain the purest distilled water, as pure as the rain water itself, with this method.

Actually, we should stop for a moment to realize that all processes, whether they are membrane processes or other artificial distilltaion processes using fuel or electric power, have to consume actually fuel, coal, oil, perhaps hydroelectric power, but power is necessary, which man has to make. However, solar distillation methods would use entirely the sun only as the source of power, and in this way we would conserve our fuel supplies which otherwise would have to be used to produce fresh water from sea water.

Besides, we all know that the sun is, above all, responsible for desert conditions or for lack of water, and you know in tropical countries, in the arid desert regions, there is a tremendous amount of sun mostly all the time. If we could convert all of this solar energy into producing fresh water, even with the simplest of processes we may be obtaining two pounds of fresh water daily from each square foot of surface which receives sunshine at a favorable angle.

Now a device of this type has actually been made some 70 years ago in Chile, near the equator, or almost, and this device has been very satisfactory and it has been in operation for at least 36 years continuously. It covers almost an acre and it was quite satisfactory, although it was too expensive and too inefficient at that time.

These experiments had been quite forgotten when during the war it became imperative that fresh water should be obtained from sea water for life rafts. I was lucky at that time to be interested at MIT in solar stills and devised these which have been actually used in life rafts and are still standard equipment on board Army and Navy life rafts. These [indicating chart] are closed in the life raft, are inflatable, and produce about enough water for a man a day. Actually I understand several hundred thousand units have been actually acquired for this purpose.

Now the next slide shows a land edition, a land-sized edition. This is a skeleton made of wood. Sea water is in the bottom of this still in a pan. The sun shines through the top, which is transparent, heats the water in the pan, it vaporizes and condenses inside of this stand [indicating] and runs down as fresh water.

In the next slide I show a still of this type, only a larger type, which is next to the ocean, as you can see. You can see the water running in here [indicating]. This actually I built almost 10 years ago. But large stills of this type were actually used and have been experimented with at the University of California by Dean Everett Howell, who is in charge of that project. Those stills, which cover 1,000 square feet in area, have been in operation for almost 3 years now continuously.

On the next line I show a totally different type of possibility, using reflector which has been built in Egypt in 1913. This parabolic reflector is arranged so that the radiation must focus, so that steam would be generated. The steam, of course, could be used in any conventional type of process of distillation. The Battelle Memorial Institute under Dr. Landry, has made a study of the possibility. It was not an experimental study, but an engineering evaluation, and the conclusion was reached that it is completely feasible to produce fresh water from sea water, but it would be much too expensive.

On the next slide I show an experimental unit made by the Bjorksten Laboratories, Dr. Johan Bjorksten, which is really roof-sized unit, which I showed you before, and using plastic material instead of a glass top because it is expected that plastics may be cheaper. It is, of course, dubious when plastics will actually be durable. We know that glass is because the Chile solar still which uses a glass actually survived 36 years. Some of the plastics made have only been in existence for a few years. I mean a good type of plastic.

This next slide will show you a different type of still, which is a long tubular still, which has similar possibilities of perhaps lower cost. We do not know yet.

I forgot my newest type of still, which is a tilted still in contrast to the roof-type still. This is the hope of possibly making stills which will be durable at a lower cost, and there is also the possibility, which is easily done because it reduces the initial investment costs, and it would probably decrease the operating costs to a minimum.

That is all the slides I have.

You may well ask, what are the possibilities?

In conclusion, I would like to state, at the present time the investment in any size of waterworks is approximately $1 to $4 daily-gallon water production. In California some of the big institutions in San Francisco or Los Angeles with the long-range aqueducts have an initial cost of some $4 per daily-gallon water yield. It is possible that solar distillation may be produced at such a figure or possibly even slightly lower. The operation, of course, will definitely be the lowest cost possible because the fuel is actually free for the taking.

I believe solar distillers have great possibilities in the arid tropical zone, in most of the southern parts of the United States, and this will be a natural process where you have the least reliance on any other fuel or power resource except the sun, which is the most powerful source, even above any atomic power or other power expectation.

So I hope that you have been convinced that solar energy has some merit, especially in California and Southern States.

Thank you.

Mr. ASPINALL. Thank you very much, Doctor.

Now will the other witnesses return to the witness stand?

It has been a very interesting presentation. The committee is very sorry that the time has been so short. That is the way we do things in Congress generally. We do not have time enough to get to the bottom of matters as we would like.

Does the gentleman from Texas have any questions?

Mr. ROGERS. I have no questions right at the present, except the observation that I was in Boston with the committee last year and enjoyed very much that visit.

Of course, water is something that is vital to my section of the country and we were very interested in the processes.

I sincerely hope that these splendid and very able scientists will be able to do something that will relieve us of the tragic situation in our section of the country.

Mr. ASPINALL. The gentleman from Pennsylvania?

Mr. SAYLOR. Mr. Chairman, I would like to commend the four witnesses we have had on their excellent presentation of the respective methods of producing water. I would like to ask them just one question.

As scientists, do you feel that our committee by limiting this experiment which you are undertaking to merely saline water is preventing you from doing the kind of research that you should do?

The reason I ask that question is this: It has come to my attention that in certain sections of the country, when they drill sometimes they get oil, sometimes they get gas, but many times they get water. The type of water that they get in those holes may have in it a tremendous amount of minerals. The question is whether or not, by being limited, as you have been in the past, to merely the saline feature you have been hampered, and whether or not we should expand this to provide you with a free hand in research to producing water from whatever source possible, whether it be water full of sulfur, or other minerals which make it unpotable and unusable. I do not care which one answers the question. I would just like to have the information for the benefit of this committee, your honest appraisal of it.

Dr. HICKMAN. May we say, sir, we consider our project applicable on the whole range. We are not in the least bit cramped.

Dr. TELKES. Solar distillation, of course, would distill any water and would produce pure distilled water from it. It makes no difference whether it is sulfur or any other type of material.

Dr. LASERSON. I would like to add, the process I have described looks economically best for high concentration of salt water. For low concentration brackish water and other mineralized waters, I think I should defer to Dr. Murphy to mention something about ion exchange membranes, which are probably more economical.

Dr. MURPHY. For low concentrations of salt, any ionized material, which includes common salt and the things which contribute to it in the water—the electrical membrane is more efficient the lower the concentration. Consequently, I would think that method would have considerable application in certain types of water that are less familiar than the brackish waters and sea waters.

I think I would like to make the additional general comment, however, that there has been a clear demonstration of the need for demineralization of both brackish and sea water, and I think this other question you bring up should be considered in the light of the need at the point these waters are found.

Mr. ROGERS. Will the gentleman yield?

Mr. SAYLOR. Yes.

Mr. ROGERS. One of the plants was taken to Arizona last fall, was it not?

Dr. MURPHY. Yes.

Mr. ROGERS. That is the membrane process?

Dr. MURPHY. Yes.

Mr. ROGERS. For the purpose of separating the water, that is, underground waters?

Dr. MURPHY. Yes.

Mr. ROGERS. I wonder if there is a report prepared or filed on that yet.

Dr. MURPHY. Those tests, I believe, have just gotten underway. That is, there was considerable timelag in getting the equipment down there and setting it up. They have performed some trial runs on it, but there is no formal report as yet.

Mr. ASPINALL. Mrs. Pfost?

Mrs. PFOST. Mr. Chairman, I would like to ask Dr. Telkes about the little stills which you showed in the slide that are taken out on the large lift raft, which produce approximately a quarter of a gallon or at least a quart of water each day per man, is that completely in the experimental stage or are they being supplied in quantity?

Dr. TELKES. Those little stills are standard equipment on liferafts right now. They are standardly issued with the liferafts. Some several hundred thousand units have been actually manufactured for liferaft use and are in use. The only difficulty is that these are very expensive units. On liferafts you have to spare volume and weight; therefore, these must be made to inflate and to occupy the least space. They are not useful at all for land, just especially for liferafts.

For land use, of course, a totally different type of still is desired, which should be rigid, not blown about by the winds, and which would not have to float. Although it would be possible to use large installations of these models that would float in lagoons near the seashore. That is also a possibility. In this way you would eliminate the need of building on land near the ocean. These are not experimental any more. They are actually in use, although they are much too expensive to be used for large-scale water conversion.

Mrs. PFOST. What is used for the top covering on the stills? Is it plastic?

Dr. TELKES. It is a plastic material, a vinylite. It is similar to the raincoat materials which everybody is faimilar with. However, that material is not durable enough so that it could not be used without any difficulty for a long-range installation. One of the other considerations to take into account is that devices one should build should last at least 20 years, or, I believe, perhaps, some of them 30 years. As far as we know the material requirements are for 20 or 30 years. They must be very exacting.

Mrs. PFOST. Thank you. Now, on your solar experiments, do you find that there is sufficient sunshine on both the east and west coasts here in the States that you feel it would be a practical solution for desalting the sea water?

Dr. TELKES. I believe that the solar devices would be useful primarily in regions which have plenty of sunshine all the year round and which need water very badly.

As somebody mentioned, in San Diego or in some other places they would be glad to have water even if it cost $300 per acre-foot.

Now actually where water is the most urgently needed and where the sun is very strong, those will be the regions which logically would go in for solar distillation first. I am not suggesting that in Chicago or in New York or in similar regions you would use solar distillation at all, nor that should be reserved to the very, very sunny South.

Mrs. PFOST. Thank you very much, Dr. Telkes.

Mr. ASPINALL. The Chair recognizes the gentleman from Arizona, Mr. Rhodes.

Mr. RHODES. Dr. Murphy, I am interested in your previous discussion of the new process which you have, in which you stated that perhaps no electricity would be required. From what little I know about the process, you use an electrolytic process to ionize or break down the molecules; do you not?

Dr. MURPHY. No. The ions are already in solution. That is, as soon as you dissolve the sodium chloride in solution it forms ions automatically. The present electrical process simply moves ions, moves the positive ion this way [indicating] and moves the negative ion that way [indicating], and by a sorting action of these membranes you get compartments which are free of both ions and other compartments which have more than they started with. But it does not break up the salt.

Mr. RHODES. What do you use energy for—just to transport the water from one place to another?

Dr. MURPHY. You use it to transport the salt from one place to another; that is right.

Mr. RHODES. What type of membrane do you use?

Dr. MURPHY. We at New York have only been doing some small-scale experimentation with commercial membranes made by Rohm & Haas. Of course, the Ionics Co. has the contract with the saline water conversion program and makes their own membranes, and they have not disclosed the exact nature of these membranes.

Mr. RHODES. Dr. Telkes, in the solar-energy process thus far, as I analyze the project, you apply the solar energy directly to the water. Has there been any experimentation involving the possibility of a solar to perhaps provide the energy for some of the other projects such as the still which Dr. Hickman talked about?

Dr. TELKES. There are some experimental installations. Solar furnaces have been built. I built one myself. It is possible to derive power from solar furnaces, see, or from parabolic reflectors such as I have shown in the slide. However, the outlook for solar power to operate these other devices seems to be one which is technically feasible, but it might be too expensive for practical use. Estimates have been made by Dr. Lof under one of the contracts, and he came to the conclusion that at the present time electric power or motive power from solar energy would still be too expensive and, therefore, the use of solar energy for distillation would be less expensive and more desirable.

Mr. RHODES. That is all.

Mr. ASPINALL. Thank you. Again we thank all of you very much. We wish we had more time. I am sure you have contributed very extensively to the program.

Thank you, Mr. Jenkins, for making this information available to us.

The committee is adjourned.

(Whereupon, at 12:10 p. m., the committee recessed to reconvene at 10 a. m., Thursday, February 24, 1955.)

CONVERSION OF SALINE WATER TO FRESH WATER

THURSDAY, FEBRUARY 24, 1955

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON IRRIGATION AND
RECLAMATION OF THE COMMITTEE ON
INTERIOR AND INSULAR AFFAIRS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 11:05 a. m., in the committee room, New House Office Building, Hon. Wayne N. Aspinall (chairman) presiding.

Mr. ASPINALL. The Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs will be in session for the further consideration of H. R. 2104 and H. R. 2126, identical bills.

At the last hearing we had placed in the record the report from the Department, which included the reference to the position of the Bureau of the Budget, which reference reads as follows:

> The Bureau of the Budget has advised that there would be no objection to the submission of this report to your committee but that no commitment can be made at this time with respect to the amount of $6 million which the bill, if enacted, would authorize to be appropriated.

This is rather a peculiar statement to have included in a departmental report and can be given different meanings. Because of that situation I asked our staff member, Mr. McFarland, to find out, if he could, why it was included as far as the meaning of the Bureau is concerned.

Mr. McFarland, will you explain to the committee?

Mr. MCFARLAND. Yes, sir, Mr. Chairman.

At your request I did call the Bureau of the Budget and talked to Mr. Green of the staff who worked on this particular legislation. The Bureau of the Budget does favor the continuation of this research program. The Bureau of the Budget did not want to be committed to the expenditure of $6 million in this specific 10-year period.

In other words, the Bureau of the Budget took the position that the Department should justify year by year the budget request based upon the work they proposed for that particular year.

I might just, in elaborating a little further, say that the legislation does not direct the executive branch to spend $6 million in 10 years.

Mr. ASPINALL. And Mr. McFarland, as I understand the procedure, it will be necessary for the Department to present its request to the Bureau of the Budget, as usual, each year and justify its request for funds, and then they must come before the proper committees of the Congress and further justify their request. Is that not right?

Mr. MCFARLAND. That is right.

Mr. SAYLOR. In other words, Mr. McFarland, the only effect then is that while the Bureau of the Budget approves this project and approves the type of work that is being done by the Interior Department in this respect, they are not going to tie their hands for the next 10 years. Is that in a sense what they have said?

Mr. MCFARLAND. That is correct.

Mr. ASPINALL. At the conclusion of our last hearing on this legislation it was stated by the chairman that we would have before the committee this morning for questioning, Mr. Frye and Mr. Jenkins of the Bureau. Will you gentlemen take your chairs at this time.

STATEMENTS OF EDWARD FRYE, SPECIAL ASSISTANT TO ASSISTANT SECRETARY AANDAHL, AND DAVID S. JENKINS, DIRECTOR, SALINE WATER CONVERSION PROGRAM, DEPARTMENT OF THE INTERIOR

Mr. ASPINALL. Do either of you gentlemen have any further matters which you wish to present to the committee?

Mr. FRYE. I have nothing further, sir.

Mr. JENKINS. Mr. Chairman, we have one additional letter from from one of the advisers. Earlier seven letters had been received concerning this proposed legislation. One additional letter from the president of Massachusetts Institute of Technology has been received.

Mr. ASPINALL. Will you hand the letter to Mr. McFarland, please?

(The letter was handed to Mr. McFarland.)

Mr. ASPINALL. This is a copy of a letter which you have in your possession?

Mr. JENKINS. Yes, Mr. Chairman.

Mr. ASPINALL. Without objection, this letter will be made a part of the record of the hearings.

Hearing no objectlon, it is so ordered.

(The letter referred to follows:)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
Cambridge, Mass., February 16, 1955.

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior,
United States Department of the Interior,
Office of the Secretary, Washington 25, D. C.

DEAR MR. AANDAHL: I am glad to express my concurrence with the proposal that Congress be requested to extend the Saline Water Act for a period of 5 years. It is important that there be a sustained program of research and development if we are to come up with new developments, and the extension of the act will help to accomplish this.

Yours sincerely,

J. R. KILLIAN, Jr., *President.*

Mr. ASPINALL. Do you have anything else, Mr. Jenkins?

Mr. JENKINS. I have no other testimony, Mr. Chairman.

Mr. ASPINALL. Does any member of the committee wish to question further either Mr. Frye or Mr. Jenkins?

Mr. SAYLOR. I have just one question. I think both of you gentlemen were in the room the other day when I asked the four scientists you had here for your demonstration the question of whether or not by using the words "saline waters" we were limiting them in their research in any way. You will recall that three of them stated that

the processes that they were using were such that they would produce potable water regardless of what type of water was used, and the fourth gentleman stated that his experiment was based solely upon sea water.

Mr. JENKINS. Yes.

Mr. SAYLOR. Now the question I would like to ask is whether or not you feel that the words "saline water" as used in this bill is broad enough to cover brackish waters, sulfur waters, or any other waters containing minerals of any sort that you might be called upon to turn your scientists loose on to produce pure water.

Mr. JENKINS. Yes, Mr. Saylor, I believe that the term "saline water" is sufficiently broad to cover all salts that are dissolved in waters, and that includes quite a long list of many, many different compounds. The sulfates, the sulfur waters that were mentioned earlier are saline waters. We are inclined to consider saline waters as those containing only sodium chloride, table salt, but some of the greatest problems, especially in industrial waters, arise from salts other than sodium chloride.

We have had many inquiries from different potential users of demineralized water. One has come from the oilfield people who have a problem with oilfield brines. Those brines contain many different salts other than sodium chloride. I think the term is sufficiently broad.

It might be interesting and possibly it might be well if there were placed in the record a table which I have showing some 44 different elements contained in sea water, all of which are considered as a salt of one kind or another.

Mr. SAYLOR. Mr. Chairman, I ask unanimous consent that the list Mr. Jenkins has referred to be made a part of the record.

Mr. ASPINALL. You have heard the request. Is there any objection?

Hearing no objection, it is so ordered.

(The table referred to follows:)

Elements in solution in sea water

Element	Parts per million	Pounds per acre-foot	Unit market value	Value per acre-foot
Chlorine	18,980	51,600	$0.03 per pound	$1,543.00
Sodium	10,561	28,700	$0.16½ per pound	4,735.50
Magnesium	1,272	3,460	$0.20 per pound	692.00
Sulfur	884	2,400	$18 per ton	21.60
Calcium	400	1,090		
Potassium	380	1,030		
Bromine	65	177	$0.21 per pound	37.17
Carbon	28	76	$100 per ton	3.80
Strontium	13	35.4		
Boron	4.6	12.5		
Silicon	.02–4.0	.05–10.9	$22 per ton	.10
Fluorine	1.4	3.8		
Nitrogen (compound)	.01–0.7	.03–1.9		
Aluminum	0.5	1.36	$0.16 per pound	.20
Rubidium	0.2	0.55		
Lithium	0.1	0.27	$10 per pound	2.70
Phosphorus	.001–0.10	.003–.272	$0.33 per pound	.08
Barium	0.05	.136	$0.10 per pound	.02
Iodine	0.05	.136	$2.40 per pound	.33
Arsenic	.01 –.02	.027 –.055	$0.85 per pound	.04
Iron	.002–.02	.0055–.055	$0.72 per pound	.03
Manganese	.001–.01	.0027–.027	$0.35 per pound	.01
Copper	.001–.01	.0027–.027	$0.18 per pound	
Zinc	.005	.0136	$0.10 per pound	
Lead	.004	.0109	$0.12 per pound	
Cesium	.002	.0055		
Uranium	.0015	.0041		
Molybdenum	.0005	.00136	$2.80 per pound	.39
Thorium	.0005	.00136		
Cerium	.0004	.00109	$1.25 per pound	.15
Silver	.0003	.00082	$0.73 per ounce	.96
Vanadium	.0003	.00082		
Lanthanum	.0003	.00082		
Yttrium	.0003	.00082		
Nickel	.0001	.00027	$0.40 per pound	
Scandium	.00004	.00011		
Mercury	.00003	.00008	$1.00 per pound	
Gold	.000006	.000016	$35.00 per ounce	.90
Radium	0.2–3×10–10	0.55–8.15×10–10		
Cadmium			$2.00 per pound	
Chromium			$1.12 per pound	
Cobalt			$1.80 per pound	
Tin			$0.77 per pound	
Selenium	.004	.0109		

Mr. ASPINALL. Mr. Rhodes, do you have any questions?

Mr. RHODES. I have no questions.

Mr. ASPINALL. Mr. Utt, do you have any questions?

Mr. UTT. No questions.

Mr. ASPINALL. Thank you very much, Mr. Frye and Mr. Jenkins for your presentation. It has been very instructive and very entertaining for scientific matters as far as laymen are concerned.

Mr. SAYLOR. I might say, to corroborate your statement, I do not believe I have ever seen a series of hearings by this committee in which there was more interest by members on a matter which to some people might be very abstract. It was produced in such a manner that it held the attention of the committee, and I think the Bureau and Mr. Frye and Mr. Jenkins should be commended for it.

Mr. FRYE. Thank you.

Mr. ASPINALL. The hearings are closed. We will now go into executive session.

(Whereupon, at 11:20 a. m., the committee proceeded in executive session, and subsequently favorably reported H. R. 2126 to the full committee. H. R. 2104, an identical bill, was tabled.)

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